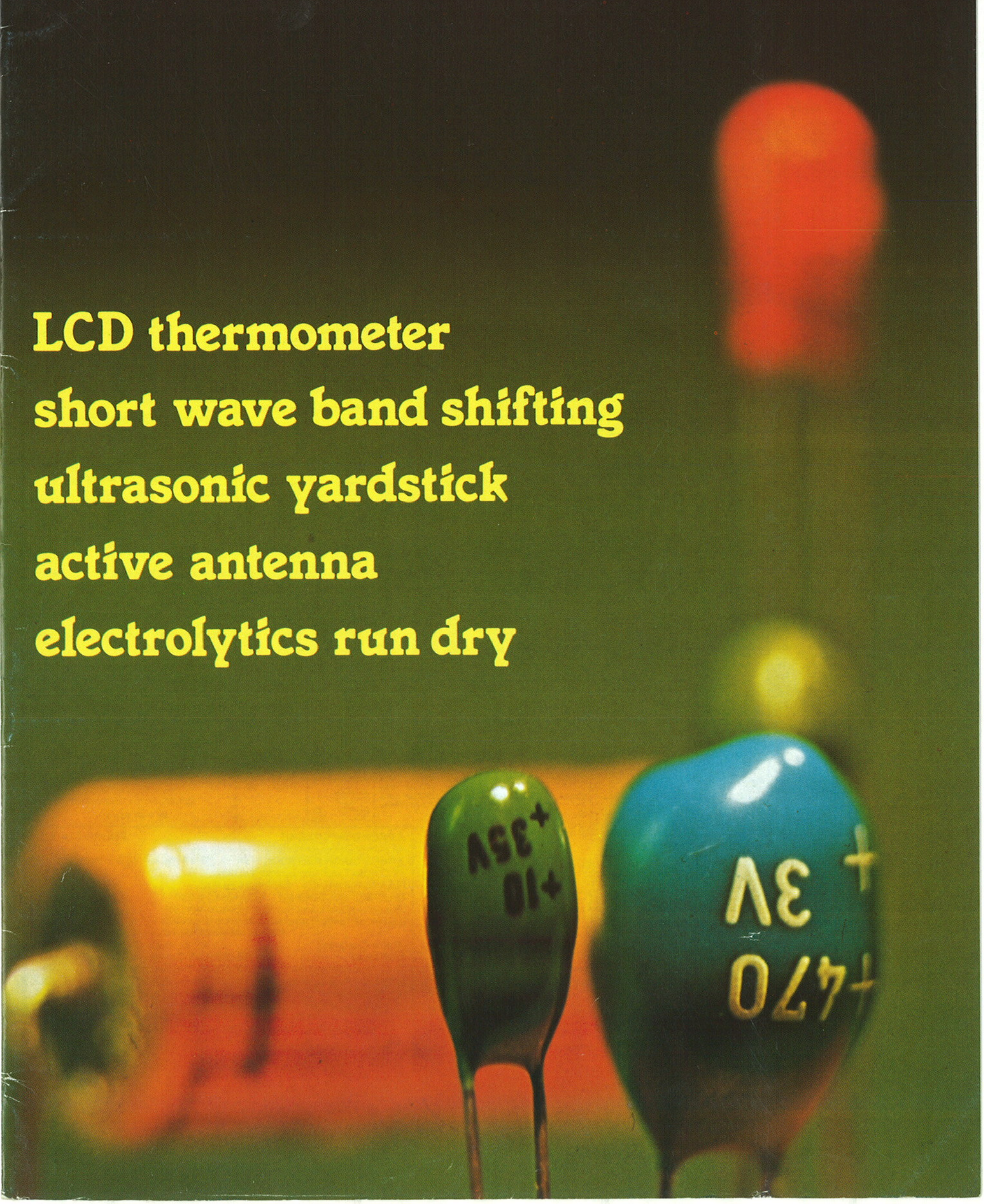
elektor

up-to-date electronics for lab and leisure

D 71683
90
October 1982
75p.
IR 114 p. (incl. VAT)
$ 2.50

LCD thermometer
short wave band shifting
ultrasonic yardstick
active antenna
electrolytics run dry



TTLs

7400	11p
7401	11p
7402	12p
7403	12p
7404	12p
7405	15p
7406	20p
7407	20p
7408	14p
7409	14p
7410	14p
7411	18p
7412	18p
7413	18p
7414	28p
7416	20p
7417	20p
7420	15p
7421	20p
7422	20p
7423	20p
7425	25p
7426	28p
7427	22p
7428	26p
7430	14p
7432	22p
7433	22p
7437	25p
7438	25p
7440	15p
7441	70p
7442A	32p
7443	90p
7444	90p
7445	50p
7446A	60p
7447A	36p
7448	45p
7450	15p
7451	15p
7453	15p
7454	15p
7460	15p
7470	36p
7472	25p
7473	25p
7474	20p
7475	25p
7476	30p
7480	50p
7481	100p
7482	70p
7483A	38p
7484	65p
7485	60p
7486	20p
7489	210p
7490A	20p
7491	35p
7492A	25p
7493A	24p
7494	35p
7495A	35p
7496	40p
7497	90p
74100	80p
74104	65p
74105	65p
74107	22p
74109	25p
74110	55p
74111	70p
74116	50p
74118	60p
74119	80p
74120	60p
74121	25p
74122	40p
74123	40p
74125	34p
74126	34p
74128	36p
74132	30p
74136	28p
74141	55p
74142	200p
74145	50p
74147	90p
74148	70p
74150	50p
74151A	40p
74153	40p
74154	50p
74155	40p
74156	40p
74157	30p
74159	75p
74160	60p
74161	48p
74162	48p
74163	48p
74164	48p
74165	48p
74166	48p
74167	200p
74170	120p
74172	275p
74173	60p
74174	55p
74175	50p
74176	40p
74177	45p
74178	80p
74180	40p
74181	115p
74182	60p
74184A	90p
74185	90p
74186	500p
74188	250p
74190	48p
74191	48p
74192	48p
74193	48p
74194	48p
74195	48p
74196	48p
74197	48p
74198	85p
74199	85p
74221	55p
74251	70p
74259	150p
74278	100p
74279	50p
74283	55p
74284	175p
74285	175p
74290	100p
74293	100p
74298	100p
74365	50p
74366	50p
74367	50p
74368	50p
74390	100p
74393	100p
74490	120p

74LS SERIES

74LS00	11p
74LS02	12p
74LS03	12p
74LS04	12p
74LS05	12p
74LS08	12p
74LS09	12p
74LS10	13p
74LS11	13p
74LS12	12p
74LS13	20p
74LS14	34p
74LS15	15p
74LS20	12p
74LS21	12p
74LS27	16p
74LS30	12p
74LS32	14p
74LS33	15p
74LS37	15p
74LS38	15p
74LS42	30p
74LS47	36p
74LS51	14p
74LS55	15p
74LS73	18p
74LS74	16p
74LS75	18p
74LS76	18p
74LS83	38p
74LS85	50p
74LS86	18p
74LS90	24p
74LS92	32p
74LS93	24p
74LS96	40p
74LS107	40p
74LS109	27p
74LS112	22p
74LS113	22p
74LS114	22p
74LS122	36p
74LS123	34p
74LS124	90p
74LS125	24p
74LS126	25p
74LS132	40p
74LS133	30p
74LS136	25p
74LS138	30p
74LS139	30p
74LS145	70p
74LS147	160p
74LS148	75p
74LS151	40p
74LS153	40p
74LS154	90p
74LS155	32p
74LS156	36p
74LS157	27p
74LS158	30p
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74LS162	36p
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74LS164	40p
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74LS375	45p
74LS377	60p
74LS378	60p
74LS390	50p
74LS393	45p
74LS399	160p
74LS445	100p
74LS540	75p
74LS541	100p
74LS640	160p
74LS641	170p
74LS642	200p
74LS643	200p
74LS644	250p
74LS668	200p
74LS669	120p
74LS670	140p

4000 CMOS

4000	10p
4001	10p
4002	12p
4006	50p
4007	15p
4008	40p
4009	24p
4010	24p
4011	11p
4012	16p
4013	23p
4014	48p
4015	45p
4016	20p
4017	36p
4018	45p
4019	25p
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4024	32p
4025	15p
4026	80p
4027	24p
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4031	125p
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4034	140p
4035	60p
4036	275p
4037	115p
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4052	60p
4053	50p
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4066	27p
4067	250p
4068	14p
4069	14p
4070	14p
4071	14p
4072	14p
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4081	14p
4082	15p
4086	55p
4089	150p
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4095	75p
4096	70p
4097	290p
4098	90p
4099	100p
40100	220p
40101	132p
40102	150p
40103	180p
40104	99p
40105	120p
40106	45p
40107	60p
40108	100p
40109	100p
40110	280p
40114	250p
4502	60p
4503	40p
4507	35p
4508	140p
4510	30p
4511	48p
4512	48p
4514	120p
4515	120p
4516	60p
4518	40p
4520	60p
4521	120p
4526	60p
4527	60p
4528	50p
4532	70p
4534	470p
4536	300p
4538	90p
4543	75p
4553	270p
4555	35p
4556	35p
4560	170p
4566	170p
4568	300p
4569	180p
4572	30p
4583	90p
4584	45p
4585	100p
4724	150p
40014	90p
40085	90p
40097	50p
14411	700p
14412	900p
14433	1100p
14495	400p
14500	700p
14599	290p
CD22100	350p
CD22101	700p
CD22102	700p

COUNTERS

74C925	550p
74C928	600p
ICM7216B	2000p
ICM7217A	850p
MK50398N	750p
ZN1040E	700p

TTL & ECL

MC4024	325p
4044	325p
10116	70p
10231	350p

LINEAR I.Cs

AY1-0212	600p	MC1496	70p
AY1-5050	140p	MC3340P	120p
AY3-8910	450p	MC3401	
AY3-8912	650p	MC3403	90p
AY5-1224A	240p	MK50398	750p
AY5-4007D	520p	ML920	800p
CA3019	80p	MM57160	620p
CA3046	70p	NE531	150p
CA3038	225p	NE555	18p
CA3080E	72p	NE556	60p
CA3086	48p	NE564	420p
CA3089E	225p	NE565	130p
CA3090AQ	375p	NE566	155p
CA3130E	90p	NE567	140p
CA3140E	50p	NE571	425p
CA3160E	100p	NE5534A	250p
CA3161E	190p	RC4136	70p
CA3162E	450p	RC4151	200p
CA3189E	300p	S566B	260p
DAC1408-8	200p	SAA1900	£16
HA1388	270p	SAD1024A	1250p
ICL7106	850p	SFF96364	800p
ICL8038	300p	SL490	350p
LF13331	310p	SN76477	175p
LF351	48p	SP8515	750p
LF356P	95p	TA7205	90p
LM10C	425p	TAA550	50p
LM301A	27p	TAA621	275p
LM310	120p	TBA641B	300p
LM311	75p	TBA651	200p
LM318	200p	TBA800	90p
LM319	225p	TBA810	100p
LM324	45p	TBA820	90p
LM339	65p	TBA950	225p
LM348	75p	TC9109	£9
LM358P	75p	TCA210	350p
LM377	175p	TCA220	350p
LM380	75p	TCA940	175p
LM381AN	180p	TDA1004A	300p
LM386	95p	TDA1008	320p
LM387	120p	TDA1010	225p
LM389	95p	TDA1022	520p
LM393	100p	TDA1024	120p
LM394	350p	TDA1034B	250p
LM709	36p	TDA1170	300p
LM710	50p	TDA2002V	325p
LM711	70p	TDA2020	320p
LM733	100p	TDA2541	350p
LM741	18p	TLO71/81	25p
LM747	70p	TLO72/82	45p
LM748	35p	TLO74	100p
LM1886	700p	TLO84	90p
LM1889	350p	TLO94	200p
LM2917	200p	TL170	50p
LM3900	55p	UAA170	170p
LM3909	95p	ULN2003	100p
LM3911	130p	XR2206	300p
LM3914	210p	ZN414	90p
LM3915	225p	ZN419C	225p
LM3916	225p	ZN424E	135p
LM13600	125p	ZN425E8	350p
MB3712	200p	ZN426E	350p
MC1310P	150p	ZN427E8	600p
MC1458	40p	ZN1034E	200p
MC1495L	350p	ZN1040E	670p

CPU's

1802C	700p
2650A	1200p
6502	400p
6800	300p
6802	350p
6809	850p
INS8060	1100p
8080A	280p
8085A	450p
8088	£19
Z80	320p
Z80A	360p
Z80B	£16

SUPPORT DEVICES

3242	800p
6522	350p
6532	600p
6551	650p
6821	120p
6850	140p
6852	370p
8205	220p
8212	120p
8216	100p
8224	200p
8228	250p
8251	320p
8253	450p
8255	300p
8257	500p
8259	500p
8279	550p
Z80P10	280p
Z80AP10	300p
Z80CTC	280p
Z80SIO 1/2/3	£9

MEMORIES

2101-4L	400p
2102-2L	120p
2107B	500p
2111-4L	300p
2112	300p
2114L	90p
2114L-2	95p
4027	300p
4116L-2	90p
4118	400p
4164	550p
4816AP-3	270p
5101L	300p
6116P-3	500p
6116LP-3	750p
6514	300p
6810	120p

PROMS

71301	700p
74S188	275p
74S201	350p
74S287	350p
74S387	350p
74S470	600p
74S471	600p
74S571	650p
74S573	900p
82S123	300p
82S137	750p
93427	400p
93436	650p
93446	650p
93448	900p

BAUD RATE GENERATOR

COM8116	£8
MC14411	£7

EPROMS

2516	250p
2708	250p
2716	250p
2532	400p
2732	450p
2716 300nS	500p
2732 300nS	750p

UARTS

AY-3-1015D	300p
AY-5-1013A	300p
IM6402	450p
TR1602	300p
COM 8017	800p

CHARACTER GEN.

RO-3-2513U.C.	700p
RO-3-2513L.C.	700p
74S262N	500p

CRT CONTROLLER

COM 5037	£18
MC6845	£10
MC6847	£10
SFF96364	£8
9365	£60
TMS9927	£18

KEYBOARD ENCODER

AY-5-2376	700p
74C 922N	500p

CRYSTALS

100KHz	100p
200KHz	280p
1MHz	290p
1.008MHz	275p
1.843MHz	210p
2.0MHz	225p
2.457MHz	210p
3.276MHz	150p
3.57945MHz	100p
4.0MHz	150p
4.19MHz	200p
4.43MHz	110p
6.0MHz	150p
7.0MHz	150p
8.0MHz	175p
8.867MHz	175p
10.7MHz	150p
15.0MHz	350p
18MHz	200p
26.690MHz	150p
27.145MHz	200p

MODULATORS

6MHz UHF	350p
8MHz UHF	450p

TELETEXT DECODER

SAA5020	£6
SAA5030	£9
SAA5041	£16
SAA5050	£9

INTERFACE ICS

AD558	775p
AD561J	1400p
DM8123	175p
DM8131	375p
DP8304	450p
DS8835	250p
DS8836	150p
DS8838	225p
MC1488	55p
MC1489	55p
MC3446	325p
25S10	350p
3242	800p
3245	450p
58174	1200p
75107	160p
75110	160p
75150	140p
75154	160p
75182	230p
75324	250p
75361	150p
75363	300p
75365	150p
75451/2	72p
75491/2	72p
8T26	120p
8T28	140p
8T95	140p
8T97	140p
81LS95	90p
81LS96	90p
81LS97	90p
81LS98	90p
9601	110p
9602	220p

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	9p	18 pin	16p	24 pin	24p
14 pin	10p	20 pin	18p	28 pin	26p
16 pin	11p	22 pin	22p	40 pin	30p

WIRE WRAP SOCKETS BY TEXAS

8 pin	30p	18 pin	50p	24 pin	70p
14 pin	35p	20 pin	60p	28 pin	80p
16 pin	40p	22 pin	65p	40 pin	100p

JUMPER LEADS

24" Ribbon cable with DIP Headers

	14 pin	16 pin	24 pin	40 pin
Single End	145p	165p	240p	380p
Double End	210p	230p	345p	540p

24" Ribbon cable with sockets

	20 pin	26 pin	34 pin	40 pin
Single End	160p	210p	270p	340p
Double End	290p	385p	490p	540p

24" Ribbon cable with edge conn.

	20 way	34 way	40 way	50 way
Single End	275p	525p	600p	650p

24" Cable with 25 way D Connector
Male 500p Female 540p

IDC CONNECTORS

	10 way	20 way	26 way	34 way	40 way
Header Plug	90p	150p	200p	240p	270p
Receptacle	90p	165p	200p	240p	270p
Edge Conn.	200p	250p	320p	380p	560p

EURO CONNECTORS

		Plug	Socket
DIN 41612	2 × 32-way	300p	350p
angled	2 × 32-way	350p	400p
angled	3 × 32-way	400p	—

(for 2 × 32 way specify a + b or a + c)

DIN 41617	31-way	200p	200p

MIN. D CONNECTORS

	9 way	15 way	25 way	37 way
MALE				
solder	95p	135p	200p	280p
angled	160p	230p	265p	425p
FEMALE				
solder	125p	190p	245p	375p
angled	175p	240p	310p	500p
hood (top/ side entry)	100p	100p	100p	150p

37 way Centronix Type conn. **£6.50**

VOLTAGE REGULATORS

Fixed Plastic TO-220

1A	+ve		−ve	
5v	7805	45p	7905	50p
6v	7806	50p	7906	60p
8v	7808	50p	7908	60p
12v	7812	50p	7912	50p
15v	7815	50p	7915	50p
18v	7818	50p	7918	60p
24v	7824	50p	7924	60p

100mA +ve	TO-92			
5v	78L05	30p	79L05	60p
12v	78L12	30p	79L12	60p
15v	78L15	30p	79L15	60p

OTHER REGULATORS

LM309K	140p		
LM317T	200p	78MGT2C	140p
LM323K	500p	79GUIC	225p
LM723	37p	79HGKC	650p
78GUIC	200p	78PO5	900p
78HO5	550p	RC4195NB	150p
78HGKC	600p	TL497	300p

TRANSISTORS

BC107/8	11p	BC557B	16p	MJ2955	90p	2N2646	45p
BC109/C	12p.	BC558B	12p	MJ3001	225p	2N2905A	30p
BC140	40p	BC559C	18p	MJE2955	130p	2N3053	30p
BC141	40p	BCY70	18p	MJE3055	100p	2N3054	65p
BC160	40p	BCY71/2	22p	MPF102	40p	2N3055	50p
BC161	40p	BD131/2	50p	MPF103/4	35p	2N3442	140p
BC177	18p	BD135/6	50p	MPF105	35p	2N3702/3	12p
BC178/9	20p	BD139	50p	MPSA12	50p	2N3704/5	12p
BC182/L	9p	BD140	50p	TIP29A/C	45p	2N3773	300p
BC183/L	9p	BD241B	70p	TIP30A/C	50p	2N3819	22p
BC184/L	9p	BD242B	70p	TIP31A/C	60p	2N3820	40p
BC212/L	9p	BF244B	40p	TIP32A/C	75p	2N3866	100p
BC213/L	9p	BF256B	70p	TIP35C	290p	2N3904/6	18p
BC214/L	9p	BF257/8	36p	TIP36C	340p	2N4871	60p
BC327	16p	BF259	40p	TIP41A/C	72p	2N5245	40p
BC337	16p	BF337	30p	TIP42A/C	80p	2N5457/8	40p
BC338	16p	BFR96	180p	TIP2955	90p	2N5459	40p
BC477	30p	BFT66	200p	TIP3055	70p	2N6027	48p
BC516/7	40p	BFY50/1	30p	2N918	45p	3N128	120p
BC547B	16p	BFY52	30p	2N2160	350p	3N140/1	120p
BC548B	12p	BFY90	90p	2N2219A	30p	40673	75p
BC549C	18p	MJ2501	225p	2N2222A	30p	40871/2	100p

KEYBOARD SWITCHES		**EXPERIMENTOR BREADBOARDS**	
Sq. Switch	50p	Exp 300	£5.75
Digitast	75p	Exp 325	£3.25
Mini Digitast	75p	Exp 350	£3.15
Specify Colour		Exp 600	£5.25

VALVO HUMIDITY SENSOR	**£6.00**
BL 30 HR COIL	**£1.50**
MINI ORGAN IC SAA1900	**£16.00**

VERO BOARD
(COPPER CLAD)

2.5" × 5"	90p
2.5" × 3.75"	80p

MICRO BOARD

Single Eurocard	£3.80
Double Eurocard	£5.25

Vero Wiring Pen	£3.40
Wire Wrapping Tool	£4.70
Veropins (100/pkt)	50p
Spot face cutter	£1.30
Pin Insertion Tool	£1.80

LOGIC PROBE KIT **£12**

ELEKTERMINAL KIT **£50 + 70p** p & p

OPTO-ELECTRONICS

2N5777	40p	ORP60	120p
OCP71	250p	ORP61	120p
ORP12	90p	TIL78	55p

OPTO-ISOLATORS

ILD74	130p	TIL111	90p
MCT26	100p	TIL112	90p
MSC2400	190p	TIL116	90p

LEDS

0.125"		0.2"	
TIL32	55p	TIL220 Red	12p
TIL209 Red	11p	TIL222 Gr	18p
TIL212 Ye	25p	TIL228 Ye	22p
TIL211 Gr	20p	Rectangular	
TIL216 Red	18p	LEDS (R, G, Y)	30p

DISPLAYS

3015F	200p		
DL 704	140p	NSB5881	570p
DL 707 Red	140p	TIL311	600p
DL 707 Gr	140p	TIL312/3	110p
DL 747 Red	225p	TIL321/2	130p
DL 747 Gr	225p	TIL330	140p
FND357	120p	7750/60	200p
FND500	120p	**DRIVERS**	
FND507	120p	9368	250p
MAN3640	175p	9370	300p
MAN4640	200p	UDN6118	320p
MAN6610	300p	UDN6184	320p

★ SPECIAL OFFER ★

	1-24	25-99
2114L-200	100p	95p
4116-3	90p	85p
2716	250p	225p
2532	400p	375p

DIODES

BY127	12p
OA47	9p
OA91	9p
OA202	10p
IN914	4p
IN4148	4p
IN4001/2	5p
IN4003/4	6p
IN4006/7	7p
IN5401/3	14p
IN5404/7	18p
IS920	9p

BRIDGES

1A50V	19p
1A100V	20p
1A600V	30p
2A50V	30p
2A100V	35p
2A400V	45p
3A200V	60p
4A100V	95p
4A450V	100p
6A50V	80p
6A100V	100p
6A400V	120p
10A100V	200p

SCRS

1A 50V	70p
5A 400V	50p
8A 600V	140p
16A100V	200p
C106D	45p
MCR101	36p
T1C44	36p
2N3525	130p
2N4444	140p
2N5060/4	40p

ZENERS

2.7V-33V

400MW	9p
1W	15p

TRIACS

Plastic

3A 400V	60p
6A 400V	70p
6A 500V	90p
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8A 500V	95p
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16A500V	130p
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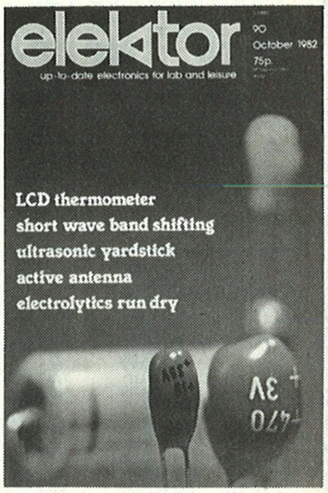

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1000V: 1nF **17p**; 10nF **30p**; 15n **40p**; 22n **36p**; 33n **42p**; 47n, 100n **40p**.

POLYESTER RADIAL LEAD CAPACITORS: 250V: 10n, 15n, 22n, 27n **6p**; 33n, 47n, 68n, 100n **7p**; 150n, 220n **10p**; 330n, 470n **13p**; 680n **19p**; 1μ **23p**; 1μ5 **40p**; 2μ2 **46p**.

ELECTROLYTIC CAPACITORS (Values in μF **500V:** 10μF **52p**; 47 **78p**; **63V:** 0·47, 1·0, 1·5, 2·2, 3·3 **8p**; 4·7 **9p**; 10 **10p**; 15, 22 **12p**; 33 **15p**; 47 **12p**; 68 **16**; 100 **19p**; 220 **26p**; 1000 **70p**; 2200 **99p**; **50V:** 68 **20p**; 100 **17p**; 220 **24p**; **40V:** 6.8 **15p**; 22 **9p**; 33 **12p** 330, 470 **32p**; 1000 **48p**; 2200 **90p**; **25V: 50p**; 3300 **76p**; 4700 **92p**; **16V:** 2·5, 40 **8p**; 47, 68, 100 **9p**; 125 **12p**; 220 **13p**; 330 **16p**; 470 **20p**; 680 **34p**; 1000 **27p**; 1500 **31p**; 2200 **36p**; 4700 **79p**.

TAG-END TYPE: 64V: 4700 **245p**; 3300 **198p**; 2200 **139p**; **50V:** 3300 **154p**; 2200 **110p**; **40V:** 4700 **160p**; **25V:** 4700 **98p**; 10,000 **320p**; 15,000 **345p**.

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1000, 1200, 1800	**30p each**
3300, 4700	**60p each**

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100V: 100n, 120n, **10p**; 150n **11p**; 220n, **13p**; 330n **18p**; 470n **23p**; 680n **30p**; 1μF **34p**; 2μ2 **50p**.

MYLAR Film CAPACITORS

100V: 1nF, 2n, 4n, 4n7, 10	**6p**
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0·5W 2Ω2-4 M7	E12	**2p**	**1p**
1W 2Ω2-10M	E12	**5p**	**3p**
2% Metal Film 10Ω	1M	**6p**	**4p**
1% Metal Film 51Ω	1M	**8p**	**6p**

RESISTORS S.I.L. Package 2%

7 Commoned: 100Ω, 680Ω, 1k, 2K2, 4K7, 10K, 47K, 100K	**25p**
8 Commoned: 150Ω, 180Ω, 270Ω, 330Ω, 1K, 2K2, 4K7, 10K, 22K, 47K, 100K	**26p**

TRANSISTORS

AC107	35
AC125/6	35
AC127/8	35
AC141/2	30
AC176	28
AC187/8	32
ACY17/18	70
ACY19/20	75
ACY21/22	75
ACY28	75
AD142	120
AD149	79
AD161/2	42
AF118	95
AF139	40
AF239	55
BC107/8	10
BC107B	12
BC108	10
BC108B	12
BC108C	12
BC109	10
BC109B	12
BC109C	12
BC117/8	20
BC140/42	30
BC143	30
BC147/8	9
BC147B	10
BC148B	10
BC148C	10
BC149	9
BC149C	12
BC153/4	27
BC157/8	10
BC159	11
BC160	45
BC167A	10
BC168C	10
BC169C	10
BC170	15
BC171/2	11
BC173	11
BC177/8	16
BC179/81	20
BC182/3	10
BC184	10
BC182L	10
BC183L	10
BC184L	10
BC186/7	26
BC212/3	10
BC212L	10
BC213L	10
BC214	10
BC214L	10
BC237/8	14
BC307B	14
BC308B	16
BC327/8	15
BC337/8	15
BC441	34
BC461	34
BC477/8	40
BC516/7	40
BC547/8	12
BC549C	14
BC556/7	15
BC558/9	15
BCY70	16
BCY71/2	20
BD121	95
BD124	115
BD131/2	48
BD133	60
BD135	45
BD136/7	40
BD138/9	40
BD140	40
BD144	198
BD205	110
BD245	45
BD378	70
BD434	55
BD517	75
BD695A	99
BD696A	99
BDY56	180
BDY60	160
BF115	35
BF167	29
BF173	27
BF177	25
BF178	30
BF179	3 5
BF180	38
BF194/5	12
BF196/7	12
BF198/9	18
BF200	30
BF224	25
BF244A	28
BF244B	29
BF256B	35
BF257/8	32
BF259	35
BF274	42
BF336	40
BF451	35
BF594/5	30
BFR39/40	23
BFR41/79	23
BFR80/81	25
BFR98	105
BFX29/84	28
BFX85/86	28
BFX87/88	28
BFY50/51	23
BFY52	23
BFY56	32
BFY64	35
BFY81	120
BFY90	80
BRY39	40
BSX20	20
BSX29	34
BSY95A	25
BU105	170
BU205	190
BU206	200
BU208	200
E421	250
MD8001	250
MJ2955	70
MJE340	54
MJE370	100
MJE371	100
MJE520	95
MJE2955	99
MJE3055	70
MPF102	40
MPF103/4	30
MPF105	30
MPF106	40
MPSA05	25
MPSA06	25
MPSA12	32
MPSA55	30
MPSA56	30
MPSA70	30
MPSU02	58
MPSU05	55
MPSU06	55
MPSU52	65
MPSU55	60
MPSU56	60
OC23/26	170
OC28/36	220
OC41/42	75
OC44	75
OC45/70	40
OC71/72	40
OC76	50
OC81/82	50
OC83/84	40
OC170/1	50
OC200/2	50
TIP29A	32
TIP29C	38
TIP30A	35
TIP30C	37
TIP31A	38
TIP31C	37
TIP32A	38
TIP32C	42
TIP33A	65
TIP33C	78
TIP34A	74
TIP34C	88
TIP35A	110
TIP35C	128
TIP36A	130
TIP36C	140
TIP41A	50
TIP41B	52
TIP42A	55
TIP42B	58
TIP120	70
TIP121	73
TIP141	105
TIP142	105
TIP147	120
TIP2955	60
TIP3055	60
TIS43	32
TIS44/45	45
TIS48	50
TIS88A	50
TIS90	30
TIS91/93	32
UC734	65
VK1010	80
VN10KM	55
VN46AF	78
VN66AF	80
VN88AF	94
VN89AF	96
ZTX107/8	11
ZTX109	12
ZTX212	28
ZTX300	13
ZTX301/2	16
ZTX303	25
ZTX304	17
ZTX314	25
ZTX320/26	30
ZTX451	23
ZTX341	30
ZTX500/1	14
ZTX502/3	18
ZTX504	25
ZTX531	25
ZTX550	25
2N696	30
2N697	23
2N698	40
2N699	48
2N706A	19
2N708	19
2N914/5	32
2N918	35
2N930	20
2N1131/2	24
2N1303/4	65
2N1305/7	60
2N1308	68
2N1613	30
2N1671B	160
2N2160	295
2N2219A	28
2N2220A	26
2N2221A	26
2N2222A	25
2N2369A	18
2N2646	45
2N2846	80
2N2904	28
2N2905A/6	26
2N2907A	26
2N2926G	10
2N3053	26
2N3054	58
2N3055	48
2N3442	140
2N3565	15
2N3614	199
2N3615	199
2N3663	15
2N3702/3	10
2N3704/5	10
2N3706/7	10
2N3708/9	10
2N3710	10
2N3771	179
2N3772	195
2N3773	210
2N3819	22
2N3820	38
2N3822/3	45
2N3866	90
2N3903/4	15
2N3906/5	15
2N4037	46
2N4058	10
2N4061/2	10
2N4069	45
2N4427	80
2N4859	78
2N4871	55
2N5135/6	20
2N5138	18
2N5172	18
2N5179	45
2N5180	45
2N5191	75
2N5194	80
2N5305	24
2N5457	30
2N5458/9	30
2N5485	36
2N5777	45
2N6027	32
2N6109	60
2N6290	70
2SA636	250
2SA671	250
2SA715	60
2SC495/6	70
2SC1061	250
2SC1096	85
2SC1162	30
2SC1172	125
2SC1173	125
2SC1306	100
2SC1307	150
2SC1449	85
2SC1679	190
2SC1678	140
2SC1923	50
2SC1945	225
2SC1953	90
2SC1957	90
2SC1969	140
2SC2028	85
2SC2029	210
2SC2078	170
2SC2091	85
2SC2166	165
2SC2314	85
2SC2465	125
2SC2547	30
2SD234	75
2SK45	90
2SK288	225
2SJ83	225
2SJ85	225
3N128	112
3N140	112
40097	120
40100	215
40101	130
40250	95
40251	150
40311	60
40313	130
40315	90
40316	95
40317/20	80
40360	60
40361/62	70
40406/7	75
40408	75
40411	285
40412	90
40467	130
40468	85
40594	105
40595	110
40603	110
40636	175
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40871/2	90

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AY-3-8912	625
AY-5-1230	450
AY-5-1317A	630
AY-5-1350	388
AY-5-4007D	520
AY-5-8100	775
CA3011	130
CA3012	175
CA3014	275
CA3018	86
CA3019	80
CA3020	210
CA3023	210
CA3028A	95
CA3035	255
CA3036	270
CA3043	275
CA3045	365
CA3046	70
CA3048	220
CA3059	285
CA3075	213
CA3080E	70
CA3081	190
CA3086	48
CA3089E	215
CA3090AQ	375
CA3123	150
CA3130	90
CA3140	40
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LA3350	250
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LC7130	340
LC7137	395
LF347	150
LF351	48
LF353	95
LF355	85
LF356	95
LF357	110
LF398	475
LM10	325
LM301A	24
LM307	45
LM308	95
LM311	70
LM318	150
LM319	215
LM324	30
LM334Z	90
LM325	128
LM339	47
LM348	64
LM349	115
LM358	60
LM377	175
LM379	480
LM380	75
LM381N	145
LM382	115
LM384	140
LM386	90
LM387	120
LM389	95
LM393	100
LM394CH	290
LM725CN	325
LM733	70
LM1871	00
LM2917	195
LM3302	75
LM3900	50
LM3909	85
LM3911	125
LM3914	180
LM3915	200
LM3916	220
LM13600	110
LS7220	280
M252AA	625
M253AA	1150
M51513L	230
M51515L	320
MB3712	220
MB3756	440
MC1303	88
MC1304P	260
MC1310P	150
MC1445	250
MC1458	35
MC1469	300
MC1494	694
MC1495	350
MC1496L	70
MC1596	225
MC1648	290
MC1709G	90
MC3302	90
MC3340P	120
MC3360P	120
MC3401	65
MC3403	75
MC3405	150
MC3423P	80
MFC6040	75
MK50398	635
ML924	275
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NE515	275
NE529	225
NE531	140
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NE544	210
NE555	16
NE556DB	45
NE560	325
NE561	395
NE562B	410
NE564	420
NE565A	120
NE566	155
NE567	140
NE570	410
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SN76013N	350
SN76018	195
SN76023N	350
SN76033	350
SN76115N	215
SN76131	125
SN76227N	95
SN76477	420
SN76488	480
SN76660	120
SP8629	299
TA7120	150
TA7130	160
TA7204	200
TA7205	90
TA7222	150
TA7310	150
TAA621AX1	295
TAA661A	190
TAA700	275
TAA900	395
TAA960	00
TAD100	159
TBA120S	70
TBA540	275
TBA550Q	330
TBA641-A12 BX1	290
TBA651	190
TBA800	80
TBA810S	95
TBA820	80
TBA920Q	200
TBA990	350
TCA270	350
TCA940	175
TCA965	120
TDA1002	00
TDA1004	290
TDA1008	310
TDA1010	198
TDA1022	499
TDA1024	420
TDA1034	350
TDA1490	325
TDA2002	325
TDA2004	495
TDA2006	300
TDA2020	320
TDA2030	295
TDB0791	420
TL061CP	40
TL062CP	60
TL064CN	98
TL071CP	24
TL072CP	45
TL074CN	100
TL081CP	24
TL082CP	45
TL083CP	75
TL084CP	90
TL091CP	55
TL170	50
UA2240	120
UA78540	230
UAA170	170
UAA180	170
UAA1003-3	935
ULN2003	85
ULN2004	90
ULN2283	100
UPC575	350
UPC1025H	375
UPC1182	330
UPC1156H	290
UPC1366	195
XR2206	300
XR2207	375
XR2211	575
XR2216	675
XR2240	1 20
XR2266	360
ZN414	80
ZN419CE	190
ZN423E	138
ZN424E	130
ZN425E-8	345
ZN426E-8	300
ZN427E-8	590
ZN428E	410
ZN429E-8	210
ZN459	570
ZN1034E	200
ZN1040E	675
ZNA234E	850

COMPUTER IC's

1702	350
1802CP	650
2101-2	150
2112-2	250
2114L-300n	80
2114L-200n	80
2147-3	425
2532-450n	350
2564	£12
2708	225
2716-5V	215
2732-450n	350
2764	£11
3242	590
4027	190
4116-150	80
4116-200	75
4118-250	325
4164-200	480
4334-3 (CMOS 2114)	325
4816-100nS	225
4864-3 64K	490
5101	220
6116-150nS	390
6116L-120nS	550
6117-100n	490
6502 CPU	325
6503	600
6504-250	550
6520	115
6521	115
6522 VIA	300
6530 RRIOT	£11
6532 RIOT	570
6545 CRTC	899
6551 ACIA	650
6592 PC	£20
6800	275
6802	335
6803	850
6804	160
6805	670
6808	520
6809	820
6810	115
6820	115
6821	115
68B21	00
6840	395
6843	£12
6845	720
6847	850
6850	135
6852	255
6875	500
68000	£59
8080A	260
8085A	450
81LS95	85
81LS96	85
81LS97	85
81LS98	85
8155	420
8123	125
8202	£25
8212	150
8214	425
8215-300	00
8216	70
8224	180
8226	250
8228	250
8251A	300
8253	798
8256A	295
8256	£35
8257A	800
8259	395
8271	£36
8284	350
8T26A	99
8T27	150
8T28A	120
8T31	350
8T95N	90
8T97N	90
9364AP	550
9602	320
AM26LS31C	125
AM26LS32A	125
AY-3-1015	300
AY-5-1013	300
AY-5-1350	388
AY-5-2376	600
AY-5-3600	750
COM8017	275
COM8116	700
DM8131	275
DP8304BN	250
DS3691N	320
DS88LS120N	275
FD1761	£15
FD1771	£15
FD1791	£22
FD1793	£23
FD1795	£28
FD1797	£28
HD26501	75
IM6402	380
INS8060N	1050
INS8154N	£10
MC1488	55
MC1489	55
MC14411	675
MC14412	775
MC3446	250
MC3447P	315
MK3886-2M	£7
MM5280D	695
MM58174	695
MM74C922	420
RO-3-2513L	700
RO-3-2513U	600
SFF96364E	800
TMS2716-3	725
TMS6011	365
ULN2003	90
UPD7002	440
Z80CPU 2.5	299
Z80ACPU4M	350
Z80CTC	265
Z80A CTC	290
Z80DART	495
Z80ADART	550
Z80DMA	895
Z80P10	260
Z80AP10	275
Z80S10-1	850
Z80A S10	980

74C Series

74C244	195
74C245	195
74C373	240
74C374	245
74C922	420

74S Series

74S00	30
74S02	32
74S04	32
74S10	40
74S20	40
74S30	40
74S32	70
74S74	75
74S132	110
74S133	60
74S138	125
74S139	150
74S158	195
74S188.	210
74S189	158
74S194	320
74S201	350
74S225	525
74S241	390
74S260	50
74S262	850
74S287	300
74S288	210
74S289	290
74S301	000
74S365	000
74S374	365
74S470	325
74S471	620
74S472	1150
74S475	825
74S571	620

75 Series

75107/8	95
75110	90
75150	125
75154	125
75182/3	99
75188/9	55
75322	140
75450	86
75451/2	52
75454	70
75491/2	65

TTL 7400

7400	11
7401	11
7402	11
7403	12
7404	13
74L04	85
7405	15
7406	20
7407	20
7408	14
7409	14
7410	14
7411	16
7412	18
7413	18
7414	20
7416	20
7417	20
7420	15
7421	20
7422	20
7423	20
7425	24
7426	28
7427	22
7428	25
7430	14
7432	20
7433	22
7437	25
7438	25
7440	15
7441	68
7442	32
7443	90
7444	90
7445	55
7446	60
7447	35
7448	40
7450	16
7451	16
7453	16
7454	16
7460	16
7470	30
7472	24
7473	24
7474	20
7475	32
7476	30
7480	40
7481	120
7482	65
7483	38
7484	70
7485	60
7486	20
7489	205
7490	20
7491	35
7492	25
7493	25
7494	35
7495	35
7496	40
7497	90
74100	80
74104	50
74105	55
74107	20
74109	25
74110	35
74111	55
74112	170
74116	50
74118	60
74119	80
74120	60
74121	25
74122	40
74123	40
74125	35
74126	35
74128	35
74132	28
74136	28
74141	55
74142	175
74143	210
74144	210
74145	50
74147	90
74148	70
74150	50
74151	40
74153	40
74154	55
74155	40
74156	40
74157	30
74159	80
74160	60
74161	48
74162	48
74163	48
74164	48
74165	48
74166	48
74167	150
74170	125
74172	275
74173	60
74174	54
74175	50
74176	40
74177	45
74178	80
74179	80
74180	40
74181	115
74182	60
74184	90
74185	95
74186	470
74188	250
74190	48
74191	46
74192	46
74193	45
74194	45
74195	46
74196	46
74197	46
74198	84
74199	85
74221	54
74246	120
74247	120
74248	120
74249	120
74251	65
74259	150
74265	55
74273	150
74276	120
74278	100
74279	50
74283	50
74284	199
74285	199
74290	105
74293	125
74297	236
74298	100
74351	195
74365	55
74366	55
74367	55
74368	55
74390	99
74393	99
74490	120

74LS

LS00	11
LS01	11
LS02	11
LS03	12
LS04	12
LS05	13
LS08	12
LS09	12
LS10	13
LS11	13
LS12	12
LS13	20
LS14	30
LS15	13
LS20	13
LS21	12
LS22	12
LS26	14
LS27	12
LS28	14
LS30	12
LS32	13
LS33	14
LS37	14
LS38	15
LS40	13
LS42	28
LS47	35
LS48	45
LS49	50
LS51	14
LS54	14
LS55	14
LS63	120
LS73	18
LS74	18
LS75	20
LS76	18
LS78	18
LS83	36
LS85	48
LS86	16
LS90	24
LS91	60
LS92	32
LS93	23
LS95	40
LS96	95
LS107	40
LS109	23
LS112	22
LS113	16
LS114	22
LS122	36
LS123	38
LS124	90
LS125	24
LS126	25
LS132	40
LS133	30
LS136	24
LS138	28
LS139	28
LS145	70
LS147	150
LS148	85
LS151	40
LS153	40
LS154	80
LS155	30
LS156	36
LS157	30
LS158	30
LS160	37
LS161	37
LS162	37
LS163	37
LS164	43
LS165	60
LS166	52
LS168	85
LS170	70
LS173	55
LS174	50
LS175	40
LS181	95
LS183	180
LS190	36
LS191	36
LS192	36
LS193	37
LS194	33
LS195	33
LS196	58
LS197	48
LS200	275
LS202	275
LS221	55
LS240	55
LS241	55
LS242	55
LS243	55
LS244	60
LS245	70
LS247	50
LS248	55
LS249	55
LS251	32
LS253	32
LS257	35
LS258	35
LS259	55
LS260	22
LS261	138
LS266	18
LS273	68
LS275	225
LS279	135
LS280	180
LS283	40
LS290	45
LS293	40
LS295	150
LS298	95
LS299	270
LS300	175
LS302	175
LS320	270
LS323	160
LS324	168
LS325	295
LS326	240
LS327	240
LS347	95
LS348	100
LS352	65
LS353	65
LS362	750
LS363	140
LS364	140
LS365	28
LS366	28
LS367	28
LS368	40
LS373	60
LS374	55
LS375	70
LS377	70
LS378	60
LS379	65
LS384	395
LS385	250
LS390	46
LS393	42
LS395	95
LS399	175
LS445	100
LS471	620
LS490	200
LS540	100
LS541	80
LS640	180
LS641	180
LS645	180
LS668	125
LS669	120
LS670	150
LS673	550

CMOS

4000	10
4001	10
4002	12
4006	50
4007	14
4008	32
4009	24
4010	24
4011	10
4012	16
4013	20
4014	46
4015	40
4016	20
4017	32
4018	45
4019	25
4020	42
4021	40
4022	40
4023	13
4024	32
4025	13
4026	80
4027	20
4028	39
4029	45
4030	15
4031	125
4032	80
4033	125
4034	140
4035	45
4036	275
4037	115
4038	110
4039	290
4040	40
4041	40
4042	40
4043	40
4044	40
4045	105
4046	46
4047	40
4048	40
4049	25
4050	25
4051	45
4052	60
4053	50
4054	85
4055	85
4056	85
4057	1915
4059	435
4060	45
4061	1195
4062	995
4063	85
4066	24
4067	245
4068	14
4069	13
4070	13
4071	13
4072	13
4073	15
4075	13
4076	50
4077	13
4078	15
4081	13
4082	13
4085	50
4086	60
4089	125
4093	20
4094	70
4095	95
4096	70
4097	190
4098	75
4099	75
4160	95
4161	99
4162	99
4163	99
4174	99
4175	105
4194	105
4408	790
4409	790
4410	725
4411	690
4412	790
4415	480
4419	280
4422	770
4433	770
4435	850
4440	999
4450	350
4451	350
4490	350
4500	675
4501	28
4502	60
4503	35
4504	75
4506	35
4507	35
4508	130
4510	46
4511	46
4512	42
4513	199
4514	125
4515	125
4516	65
4517	275
4518	40
4519	30
4520	70
4521	130
4522	125
4526	60
4527	50
4528	50
4529	150
4530	90
4531	130
4532	50
4534	455
4536	275
4538	70
4539	90
4541	140
4543	70
4544	150
4548	40
4549	375
4553	245
4554	190
4555	35
4556	35
4557	320
4558	120
4559	395
4560	160
4561	104
4562	495
4566	165
4568	250
4569	175
4572	36
4580	460
4581	250
4582	99
4583	99
4584	48
4585	99
4597	330
4598	290
4599	290
40097	45
40100	215
40101	130
40102	140
40103	175
40104	95
40105	115
40106	75
40107	60
40108	450
40109	100
40110	300
40114	240
40163	50
40174	45
40193	95
45106	595
40244	195
40245	195
40373	240
40374	245

SPREAKERS
8Ω 0·3W 2"; 2·25"; 2·5" 3" 80p
0.3W; 2.5"; 40Ω; 64Ω or 80Ω 80p

DIODES

AA119	15
AA129	20
AAY30	15
BA100	15
BAX13	20
BY100	24
BY126	12
BY127	12
CRO33	250
OA9	40
OA47	12
OA70	12
OA79	15
OA81	20
OA85	15
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
1N914	4
1N916	5
1N4001/2	5
1N4003	6
1N4004/5	6
1N4006/7	7
1N4148	4
1N5401	15
1N5404	16
1N5406	17
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A400V	50
6A800V	65

Noise Diode
25J 195

SCR's Thyristors

08A-100V	32
1A-100V	60
5A/300V	38
5A/400V	40
5A/600V	48
8A/300V	60
8A/600V	95
12A/100V	78
12A/400V	95
12A/800V	188
BT106	150
BT116	180
C106D	38
TIC44	24
TIC45	29
TIC47	35
2N5062	32
2N5064	38
2N4444	130

DIAC
ST2 25

BRIDGE RECTIFIERS
(plastic case)

1A/50V	18
1A/100V	20
1A/400V	25
1A/600V	34
2A/50V	30
2A/200V	40
2A/400V	46
2A/600V	65
6A/100V	83
6A/400V	95
6A/600V	125
10A/200V	215
10A/600V	298
25A/200V	240
25A/600V	395
BY164	56
VM18	50

ZENERS
Range 2V7 to 39V 400 mW
8p each
Range 3V3 to 33V 1·3W
15p each

VARICAPS

MVAM2	165
BA102	30
BB105B	40
BB106	40

TRIACS

3A/100V	48
3A/400V	56
3A/800V	85
8A/100V	60
8A/400V	69
8A/800V	115
12A/100V	78
12A/400V	82
12A/800V	135
16A/100V	103
16A/400V	105
16A/800V	220
25A/400V	185
25A/800V	295
25A/1000V	480
30A/400V	525
T2800D	120

SOLDERCON PINS

100	70p
500	325p

OPTO ELECTRONICS

LEDS including Clips	
TIL209 Red 3mm	11
TIL211 Green 3mm	14
TIL212 Yellow	14
TIL220 2" Red	12
0·2" Yel Grn. Amber	14
Rectangular LEDSs with two part clip R. G&Y	29
Rectangular Stackable LEDS	18
Triangular LEDS R&G	18
0·2" Flashing LED Red	55
0·2" Br colour LEDs	
Red/Green	65
Green/Yellow	80
0·2" Tricolour LEDs	
Red/Green/Yellow	85
0·2" Red High Bright	59
LD271 Infra Red (emit)	46
TIL32 Infra Red (emit)	52
SFH205 (detector)	118
TIL78 (detector)	54
TIL38	45
TIL81	82
TIL100	90
7 Segment Displays	
TIL321 5" C.An	115
TIL322 5" C.th	115
DL704 3" C.Cth	99
DL707 3" C.Anod	99
8" Orange C.A.	250
FND357 or 500	120
3" Green C.A.	140
±1·3" Red or Green	150
Bargraph 10 seg. Red	225
Bargraph NSM3914	500

FERRIC CHLORIDE
1 lb bag Anhydrous
195p + 50p p&p

DALO ETCH RESIST
Pen + Spare tip 90p

COPPER CLAD BOARDS

Fibre Glass	Single sided	Double sided
6" x 6"	90p	110p
6" x 12"	150p	195p

SRBP
9·5" x 8·5"
95p

VEROBOARDS 0·1"

	Clad	Plain
2½ x 3¾"	80p	—
2½ x 5"	91p	—
3¾ x 3¾"	91p	—
3¾ x 5"	105p	87p
3¾ x 17"	360p	232p
4¾ x 18"	470p	—
Pkt of 100 pins		50p
Spot Face Cutter		135p
Pin Insertion Tool		178p

VQ Board	180
DIP Board	374
Vero Strip	144
S100 Board	£14
PROTO-DECs	
Veroblock	405
S Dec	350
Eurobreadboard	520
Bimboard 1	695
Superstrip SS2	£13

VERO WIRING PEN and Spool 310p
Spare Wire (Spool) 75p Combs 6p ea.
Wire Wrapping Stakes 100 250p

ASTEC UHF MODULATORS
6MHz 280p 8MHz Wide band 425p

0·5" LIQUID CRYSTAL DISPLAYS

3½ digit	495
4 digit	530
6 digit	640

BPX25	195
BPW21	295
IL74	45
ILD74	99
ILQ74	185
TIL111	75
TIL117	90
OCP71	120
ORP12	78
ORP61	85
2N5777	45
4N33	135

OPTO SWITCH
Reflective
TIL139 170
Slotted similar to RS 186

ALUM. BOXES

3x2x1"	65
4x2½x2"	85
4x2¾x2½"	103
4x4x2½"	120
5x4x2"	105
5x2¾x1½"	90
5x2¾x2½"	130
5x4x1½"	99
5x4x2½"	120
6x4x2"	120
6x4x3"	150
7x5x3"	180
8x6x3"	210
10x4¼x3"	240
10x7x3"	275
12x5x3"	260
12x8x3"	295

SPECIAL OFFER

	1+	25+
2114L-2	80p	75p
2532	350p	330p
2716	215p	199p
2732	350p	330p
4116	75p	70p
4816-120ns	225p	205p
6116-150ns	390p	360p
6520/21	115p	105p
6522	300p	250p
6820/6821	115p	105p
EPSON MX80T Printer	£249	

EPSON PRINTERS

- **MX80T** 10" Tractor Feed, 9×9 matrix, 80 column, 80 CPS, Di-directional, Centronic Interface. Baud Rate 110-9600. **£275**
- **MX80FT/3** Tractor & Friction feed. Has hi-resolution, bit image graphics. Subscript & Superscript, italics & underlining facility plus all the MX80FT features. **£335**
- **NEC'S** PC-8023-C 100 cps Dot Matrix Printer **£295**

ANTEX Soldering Irons

C15W	450
CX17W	475
CCN15W	490
X25W	500
Spare Bits	65
Elements	210
Iron stands	165
Heat Shunt	30

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Access
Buy it with Access
Just phone your order through, we do the rest.

GAS & SMOKE DETECTORS
TGS812 & 813 575
Sockets 40

ULTRASONIC TRANSDUCERS
40KHz Transmitter & Receiver 325p/pair

DIL SOCKETS

	Low profile	Wire wrap
8 pin	8p	25p
14 pin	10p	35p
16 pin	10p	42p
18 pin	16p	52p
20 pin	22p	60p
22 pin	25p	70p
24 pin	25p	70p
28 pin	28p	80p
40 pin	30p	99p

ZIP DIL SOCKET

24 way	575p
28 way	850p
40 way	975p

DIL PLUGS (Headers)

Pine	Solder	IDC
14	38p	95p
16	42p	100p
24	88p	138p
40	195p	218p

RIBBON CABLE (price per foot)

Ways	Grey	Colour
10	12p	22p
16	25p	40p
20	25p	40p
26	35p	52p
34	48p	60p
40	55p	70p
60	75p	115p

WATFORD'S Ultimate Monitor IC.

A 4K Monitor Chip specially designed to produce the best from your: Superboard Series I & II. Enhanced Superboard & UK101. As reviewed by Dr. A. A. Berk in Practical Electronics, June 1981.

Price only £12.00 + 50p p&p

IDC CONNECTORS (Speed block type)

	PCB Plug with latch Strt. Pins	Angle Pins	Female Header Socket	Unshrouded PCB Plug Male Strat	Plug Angle
2× 5 way	90p	99p	85p	60p	65p
2× 8 way	130p	150p	110p	70p	78p
2×10 way	145p	166p	125p	80p	92p
2×13 way	175p	200p	150p	95p	110p
2×17 way	205p	236p	169p	110p	135p
2×20 way	220p	250p	190p	125p	150p
2×25 way	235p	270p	200p	150p	175p

EURO CONNECTORS

		SOCKETS Strt.	SOCKETS Angle	PLUGS Strt.	PLUGS Angle
DIN41617	31 way	170p	—	—	175p
DIN41612	2×32 way A + B	285p	325p	220p	295p
DIN41612	2×32 way A + C	300p	340p	240p	300p
DIN41612	3×32 way A + B + C	360p	385p	260p	400p

'D' CONNECTORS: Miniature

Pins	9 way	15 way	25 way	37 way
PLUGS				
Solder	80p	110p	160p	240p
Angle	150p	210p	250p	355p
Strait	170p	160p	220p	310p
SOCKETS				
Solder	105p	160p	200p	338p
Angle	165p	215p	290p	440p
Strait	175p	200p	300p	420p
COVERS	95p	90p	100p	110p

IDC 25-way: Plug 385p; Socket 450p

Amphenol Plugs
24 way 1EEE 575p
36 way Centonics Parallel 550p

SIL Sockets 0.1"
20-way 65p

EDGE CONNECTORS
Two Rows

	1	156
2×10 way	—	135p
2×15 way	—	140p
2×18 way	180p	145p
2×22 way	199p	200p
2×23 way	210p	—
2×25 way	225p	220p
2×28 way	235p	—
2×30 way	245p	—
2×36 way	295p	—
2×40 way	315p	—
2×43 way	395p	—
2×75 way	550p	—

TRANSFORMERS (mains Prim 220-240V): 3.0-3V 100mA; 6.0-6V 100mA; 9.0-9V 75mA: 12.0-12V 75mA: 15.0-15V 75mA 98p
6VA: 2×6V-5A; 2×9V-4A; 2×12V-0.3A; 2×15V-25A 220p
12VA: 2×4V5-1.3A; 2×6V-1.2A; 2×12V-5A; 2×15V-4A 295p
24VA: 6V-1.5A; 6V-1.5A; 9V-1.2A; 9V-1.2A; 12V-1A; 12V-1A; 15-8A; 15-8A; 20V-6A; 20V-6A 330p (44p p&p)
50VA: 2×6V-4A; 2×9V-2.5A; 2×12V-2A; 2×15V-1.5A; 2×20V-1.2A; 2×25V-2A; 2×30V-0.8A 465p (60p p&p)
100VA: 2×12V-4A; 2×15V-3A; 2×20V-2.5A; 2×30V-1.5A; 2×40V-1.25A; 2×50V-1A 920p (60p p&p)

JUMPER LEADS Ribbon Cable Assembly
DIL Plug (Headers)
Single Ended Lead 24" long

Length	14 pin	16 pin	24 pin	40 pin
24"	145p	165p	240p	380p
Double Ended Leads				
6"	185p	205p	300p	465p
12"	198p	215p	315p	490p
24"	210p	235p	345p	540p
36"	230p	250p	375p	595p

ID HEADER SOCKET Jumper Leads 24"

	20 pin	26 pin	34 pin	40 pin
1 end	160p	200p	260p	300p
2 ends	290p	370p	480p	525p

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1A	TO3	**five**	five	
5V	7805	145p	7905	220p
12V	7812	145p	7912	220p
15V	7815	145p	7915	220p
18V	7818	150p		—
1A	TO220 Plastic Casing			
5V	7805	40p	7905	45p
12V	7812	40p	7912	45p
15V	7815	40p	7915	45p
18V	7818	40p	7918	45p
24V	7824	40p		
100mA	T092 Plastic Casing			
5V	78LO5	30p	79LO5	60p
6V	78L62	30p		—
8V	78L82	30p		—
12V	78L12	30p	79L12	60p
15V	78L15	30p	79L15	60p

LM300H	170	LM305H	140
LM304H	160	LM309K	135
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78H12 12V/5A	580	LM317P	99
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79HG-2.25V to −24V 5A	785	LM723	35
		TBA625B	75

SWITCHES

SLIDE 250V		TOGGLE 2A 250V	
1A DPDT	14	SPST	33
1A DPDT C/OFF	15	DPDT	44
½A DP on/on/on	40	4 pole on/off	54
4 pole c/over	240		
PUSH BUTTON		**SUB-MIN**	
Spring loaded		**TOGGLE**	
Latching or		SP changeover	60
Momentary 6A		SPST on/off	54
SPDT c/over	99	SPDT c/off	85
DPDT c/over	145	SPDT Biased	105
		DPDT 6 tags	75
MINIATURE		DPDT c/off	88
Non Locking		DPDT on/on/on	185
Push to make	15p	DPDT Biased	145
Push break	25p	3 pole c/over	205

ROCKER: 5A 250V SPST 28p
ROCKER: (white) 10A 250V SPOT 38p
ROCKER: With neon lights red when on 10A 250V DPST 85p
ROCKER: (White) 10A 250V DPDT 72p
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Break before make Wafers, Silver contacts, 1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6 pole/2 way 65p
Mains DPST Switch to fit 45p
Screen & Spacers 6p
ROTARY: (Adjustable Stop Type)
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ROTARY: Mains 250V AC 4 Amp 56p
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200KHz	268
455KHz	370
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1·008M	275
1·28MHz	392
1·5MHz	420
1·6MHz	395
1·8MHz	395
1·8432M	200
2·0MHz	225
2·4576M	200
2·5MHz	225
2·5625MHz	00
3·2768M	150
3·57954M	98
3·6864M	300
4·0MHz	150
4·80MHz	200
4·194304M	200
4·433619M	100
4·032MHz	290
4·608MHz	200
5·0MHz	160
5·185MHz	300
5·24288M	390
6·0MHz	140
6·144MHz	150
6·5536MHz	200
7·0MHz	150
7·168MHz	250
7·68MHz	200
8·0MHz	150
8·08333M	395
8·867237M	175
9·00MHz	200
9·375MHz	350
10·0MHz	175
10·5MHz	250
10·69MHz	295
10·7MHz	150
10·24MHz	200
12·0MHz	175
12·528MHz	300
14·31818M	170
14·756M	250
15·0MHz	200
16·0MHz	200
18·0MHz	180
18·432M	150
19·968MHz	150
20·0MHz	200
24·0MHz	170
24·930MHz	325
26·69M	150
26·670MHz	325
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116·0MHz	300

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ABC

decoder

What is a TUN?
What is 10 n?
What is the EPS service?
What is the TQ service?
What is a missing link?

Semiconductor types
Very often, a large number of equivalent semiconductors exist with different type numbers. For this reason, 'abbreviated' type numbers are used in Elektor wherever possible:

- '741' stand for μA741, LM741, MC1741, MIC741, RM741, SN72741, etc.
- 'TUP' or 'TUN' (Transistor, Universal, PNP or NPN respectively) stand for any low frequency silicon transistor that meets the following specifications:

$U_{CEO, max}$	20 V
$I_{C, max}$	100 mA
$h_{fe, min}$	100
$P_{tot, max}$	100 mW
$f_{T, min}$	100 MHz

Some **'TUN's** are: BC107, BC108 and BC109 families; 2N3856A, 2N3859, 2N3860, 2N3904, 2N3947, 2N4124. Some **'TUP's** are: BC177 and BC178 families; BC179 family with the possible exeption of BC159 and BC179; 2N2412, 2N3251, 2N3906, 2N4126, 2N4291.

- 'DUS' or 'DUG' (Diode Universal, Silicon or Germanium respectively) stands for any diode that meets the following specifications:

	DUS	DUG
$U_{R, max}$	25 V	20 V
$I_{F, max}$	100 mA	35 mA
$I_{R, max}$	1 μA	100 μA
$P_{tot, max}$	250 mW	250 mW
$C_{D, max}$	5 pF	10 pF

Some **'DUS'** are: BA127, BA217, BA218, BA221, BA222, BA317, BA318, BAX13, BAY61, 1N914, 1N4148.
Some **'DUG's** are: OA85, OA91, OA95, AA116.

- 'BC107B', 'BC237B', 'BC547B' all refer to the same 'family' of almost identical better-quality silicon transistors. In general, any other member of the same family can be used instead.

BC107 (-8, -9) families:
BC107 (-8, -9), BC147 (-8, -9), BC207 (-8, -9), BC237 (-8, -9), BC317 (-8, -9), BC347 (-8, -9), BC547 (-8, -9), BC171 (-2, -3), BC182 (-3, -4), BC382 (-3, -4), BC437 (-8, -9), BC414

BC177 (-8, -9) families:
BC177 (-8, -9), BC157 (-8, -9), BC204 (-5, -6), BC307 (-8, -9), BC320 (-1, -2), BC350 (-1, -2), BC557 (-8, -9), BC251 (-2, -3), BC212 (-3, -4), BC512 (-3, -4), BC261 (-2, -3), BC416.

Resistors and capacitor values
When giving component values, decimal points and large numbers of zeros are avoided wherever possible. The decimal point is usually replaced by one of the following abbreviations:
p (pico-) = 10^{-12}
n (nano-) = 10^{-9}
μ (micro-) = 10^{-6}
m (milli-) = 10^{-3}
k (kilo-) = 10^{3}
M (mega-) = 10^{6}
G (giga-) = 10^{9}

A few examples:
Resistance value 2k7: 2700 Ω.
Resistance value 470: 470 Ω.
Capacitance value 4p7: 4,7 pF, or 0.000 000 000 004 7 F . . .
Capacitance value 10n: this is the international way of writing 10,000 pF or .01 μF, since 1 n is 10^{-9} farads or 1000 pF.
Resistors are ¼ Watt 5% carbon types, unless otherwise specified.
The DC working voltage of capacitors (other than electrolytics) is normally assumed to be at least 60 V. As a rule of thumb, a safe value is usually approximately twice the DC-supply voltage.

Test voltages
The DC test voltages shown are measured with a 20 kΩ/V instrument, unless otherwise specified.

U, not V
The international letter symbol 'U' for voltage is often used instead of the ambiguous 'V'. 'V' is normally reserved for 'volts'. For instance: $U_b = 10$ V, not $V_b = 10$ V.

Mains voltages
No mains (power line) voltages are listed in Elektor circuits. It is assumed that our readers know what voltage is standard in their part of the world!
Readers in countries that use 60 Hz should note that Elektor circuits are designed for 50 Hz operation. This will not normally be a problem; however, in cases where the mains frequency is used for synchronisation some modification may be required.

Technical services to readers

- **EPS service.** Many Elektor articles include a lay-out for a printed circuit board. Some — but not all — of these boards are available ready-etched and predrilled. The 'EPS print service list' in the current issue always gives a complete list of available boards.
- **Technical queries.** Members of the technical staff are available to answer technical queries (relating to articles published in Elektor) by telephone on Mondays from 13.30 to 16.15. Letters with technical queries should be addressed to: Dept. TQ. Please enclose a stamped, self addressed envelope; readers outside U.K. please enclose an IRC instead of stamps.
- **Missing link.** Any important modifications to, additions to, improvements on or corrections in Elektor circuits are generally listed under the heading 'Missing Link' at the earliest opportunity.

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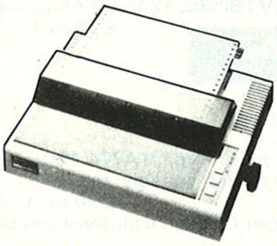

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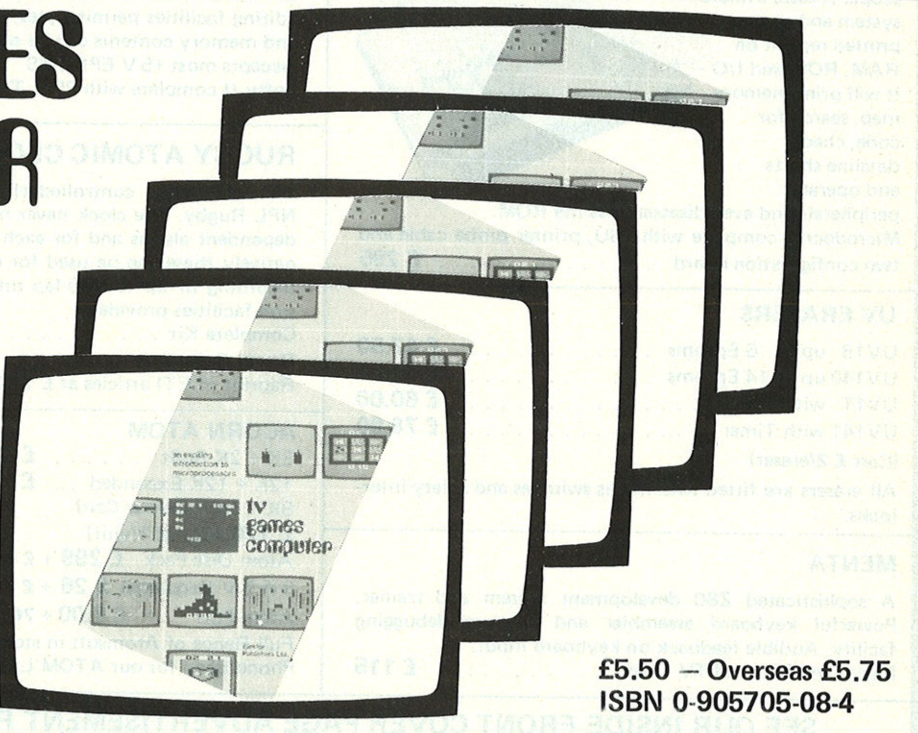
TV GAMES COMPUTER BOOK


an exciting introduction to microprocessors
tv games computer

an exciting introduction to microprocessors

The first acquaintance with microprocessors can be rather frightening. You are not only confronted with a large and complex circuit, but also with a new language: 'bytes', 'CPU', 'RAM', 'peripherals' and so on. Worse still, the finished article is a miniature computer and so you have to think up some sufficiently challenging things for it to do! This book provides a different — and, in many ways, easier — approach.

The TV games computer is dedicated to one specific task: putting an interesting picture on a TV screen, and modifying it as required in the course of a game. Right from the outset, therefore, we know what the system is intended to do. Having built the unit, 'programs' can be run in from a tape: adventure games, brain teasers, invasion from outer space, car racing, jackpot and so on. This, in itself, makes it interesting to build and use the TV games computer.

There is more, however. When the urge to develop your own games becomes irresistible, this will prove surprisingly easy! This book describes all the components parts of the system, in progressively greater detail. It also contains hints on how to write programs, with several 'general-purpose routines' that can be included in games as required. This information, combined with 'hands-on experience' on the actual unit, will provide a relatively painless introduction into the fascinating world of microprocessors!

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ISBN 0-905705-08-4

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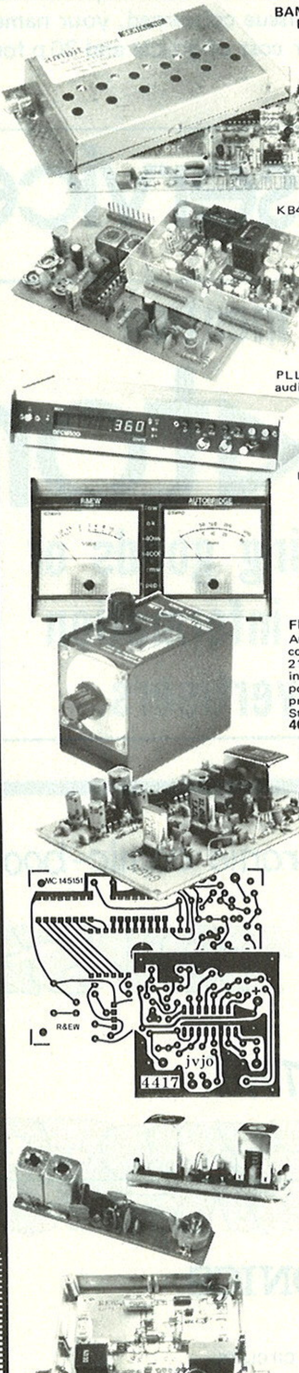

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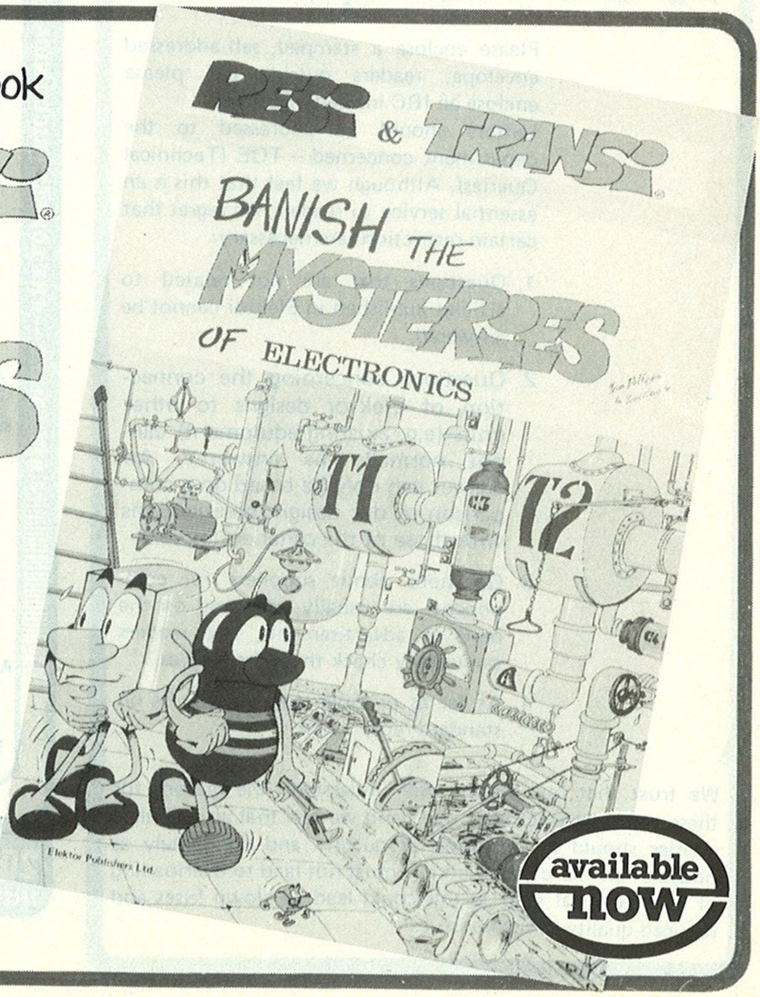

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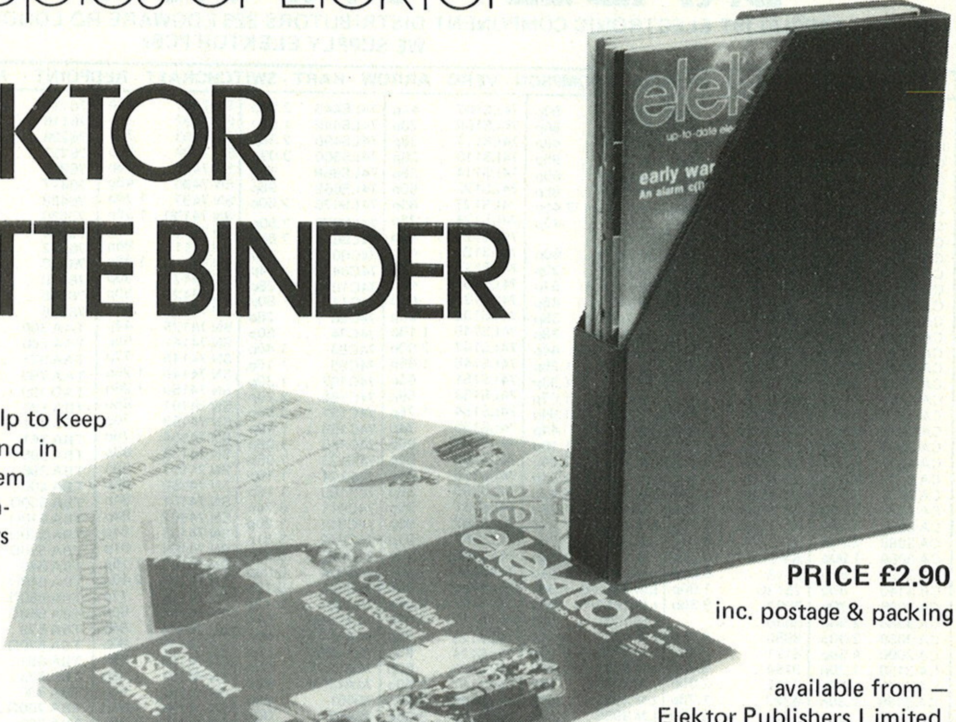

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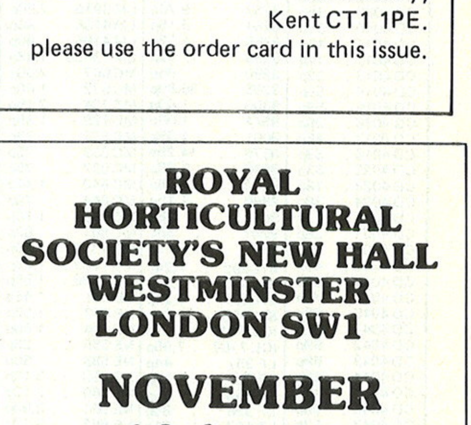

elektor switchboard

OCTOBER '82

FREE advertising for our readers!

When you have been 'into electronics' for some time, a most amazing amount of interesting gear tends to accumulate. Old valves, radios, tape decks, relays — remember the days? Or even: old microprocessor systems!

On the other hand, when you're getting into electronics, having to buy everything brand-new tends to put a slight damper on your natural urge to experiment. And even when you have an intriguing collection of bits and pieces, the bit or piece that you happen to need often seems to be the only one that is missing.

Put these two facts together, and it seems obvious that there must be a large number of readers who are looking for things that are gathering dust elsewhere. If only the two parties knew about each other's existence!

What they need is some kind of switchboard: a place where either party can mount a 'plug' or 'socket', with a reasonable chance that the other person will find it. What better place than the pages of an electronics magazine?

This month, we introduce 'switchboard': a *free* advertisement service to Elektor readers. (Admittedly, the idea is not entirely new. However, one of the basic rules for computer programmers applies in this case: 'Don't re-invent the wheel if you can steal the plans'!) The basic idea is quite straightforward: you send us a short advertisement, and we print it. Hopefully, someone responds; hey presto: two more happy readers!

However, we have given this matter some thought. If the service becomes as popular as we expect, things might tend to get out of hand. Since we are offering this advertising space free of charge, we feel justified in specifying the rules:

- Private advertisers only. No trade, no business.
- Full address or private telephone number; no post office boxes (for the reason given above!).
- Items related to electronics only. Software only when related to Elektor computer systems.
- Maximum length: 114 characters — letter, numeral, comma, space, etc. (not including address and/or telephone number).
- One advertisement per reader per month. To enforce this rule, a switchboard voucher will be printed each month. No matter how the text is sent to us — on the original form, on a photocopy or on a hand-made copy — the original voucher from the magazine must be included. Each voucher is valid for posting up to the end of the 'cover' month.
- Elektor cannot accept responsibility for any correspondence or transaction as a result of a 'switchboard' ad, nor as a result of any inaccuracy in the text.
- Ads will be placed in the order in which they are received, in the next issue if space allows.
- We reserve the right to refuse advertisements, without returning them — in general, this rule will apply if the rules given above are broken.

Pheww! I'm glad I got that lot off my chest. Personally, I'd much rather forget the rules - but they are essential of the service is to work as we intend. In simple terms, it all boils down to this: any private reader can send in an ad, and we'll place it. However, we don't want to waste space on long-winded or irrelevant messages and 'the trade' is referred to the classified ads section, where it belongs.

And now it's up to you. If you've got anything to offer, or if you're looking for something, let us know — and we'll tell the world! The first form and voucher is printed below.

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OCTOBER '82

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Power from the invisible universe

A theory linking black holes, quasars and radio jets in galaxies may explain the basis of the universe and point to its eventual end in a so-called Big Crunch.

Only a few years ago it seemed that astronomers were drawing near to a comprehensive understanding of the universe. Mysterious objects remained, notably the quasars with their extraordinary brightness, but a pattern was emerging that promised to encompass all the categories of stars and galaxies that astronomers could see.

To some extent that is still true today. But what is becoming apparent is that the universe we can observe with any kind of radiation, including radio waves, infra-red, ultra-violet and X-rays, is probably only a small fraction of the entire universe. Most of it is invisible because the matter it comprises produces no radiation for astronomers to detect with their telescopes.

But this unseen matter cannot be ignored. Although it is invisible, it is probably responsible for the most violent events in the visible universe. And its presence may be the factor deciding the fate of the universe, whether it will go on expanding for all eternity or whether it will instead stop expanding, contract and finally disappear in a Big Crunch, the precise opposite of the Big Bang in which it came into being.

Quasars and Black Holes

The two most mysterious objects in the known universe are quasars and black holes. Quasars are stange super-stars, each one shining more brightly than thousands of complete galaxies of stars, yet producing its radiation from something with a diameter no greater than that of the solar system. Because quasars shine so brightly they are visible at distances of several thousand million light years. This means that we are seeing them not as they are now but as they were several thousand million years ago, when the universe (which began at some time between ten and fifteen thousand million years ago) was relatively young. This has suggested to astronomers that, because no quasars to be nearer at hand, in more recent epochs, whatever provides the power for them may be some force which is now spent.

Black holes the fates of large stars when their nuclear fuel finally burns out. When this happens there is no longer outward explosive force to balance the inward gravitational forces caused by every particle of matter in the star attracting every other particle of matter, so the star collapses inwards and becomes more and more dense. It passes through the stage where the electrons orbiting atoms are squashed inwards to fuse with protons, the negative and positive charges cancelling each other, thereby forming neutrons. Smaller stars stop contracting at this stage and form so-called neutron stars made of collapsed atoms. They are dotted around the universe and can be detected by their gravitational effects on other stars. But in larger stars the inward gravitational forces are so strong that theory predicts they will go on collapsing inwards until all the matter in such a star has been compressed into a dimensionless point. A star which has reached that stage can no longer be observed because no radiation can leave it. For this reason, and because events inside it can no longer be understood through conventional physics, it is called a black hole.

Radio Jets

Black holes are no longer just theoretical notions. X-ray telescopes have detected radiation coming from two or three objects which are very probably other stars in orbit around black holes. More recently, there has been growing suspicion that violent events in the centres of galaxies may be caused by black holes being formed there. In the UK, Professor Martin Rees of the Cambridge Institute of Astronomy and his colleagues have put forward a theory which not only explains quasars in terms of black holes but explains another mysterious phenomenon, too, so-called jets in radio galaxies.

Radio galaxies, the main class of objects detected by radio telescopes, appear usually to contain an ordinary optical galaxy with a characteristic disc shape. Protruding from the centre of the disc in each direction perpendicular to it, giving the appearance of a wheel on an axle or of a spinning top, are jets of radiation and charged particles shooting such colossal distances into space that they dwarf the galaxy from which they come.

To understand Professor Rees's theory, it is necessary to go back in time at least ninetenths of the way to the origin of the universe, to a period about one thousand million years after the Big Bang. At that time, swirling clouds of gas were separating from each other and forming spinning, protogalactic discs with solid stars condensing out of the gas. As the stars formed, the remaining gas sank towards the centre of each galaxy, attracted by the pull of the denser matter. There were no forces, other than those which mutually repel neighbouring atomic particles, to slow down the inward collapse of the gas into each galactic centre. So collapse soon proceeded to the point where a black hole formed. More and more matter was pulled into the black hole by its enormously powerful gravitational field, so its pull grew still

Photograph of Centaurus A taken at the Anglo-Australian telescope on Sidding Spring Mountain in Australia. Centaurus A is the nearest of the great radio galaxies and is believed to have an enormous black hole at its centre.

stronger until it drew neighbouring stars into itself, as well as dust and gas.

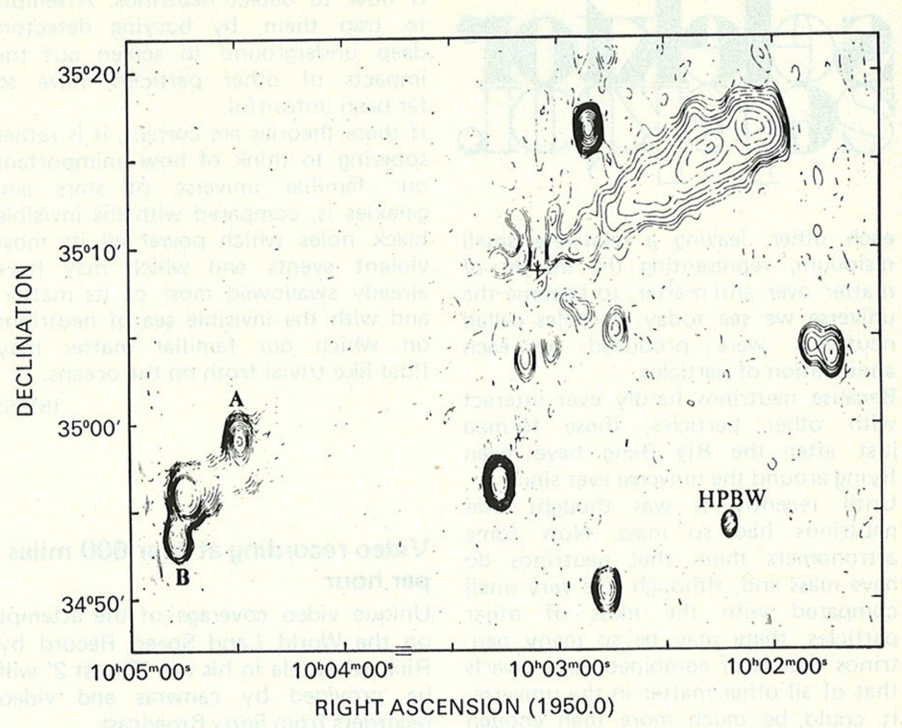
Synchrotron Radiation

This, says Professor Rees, is the stage of galactic evolution represented by the quasars. They are young galaxies in which the central black holes are still sucking in stars. While the stars are being pulled into the black hole, before they disappear for ever, they are accelerated to velocities near to the speed of light. Matter accelerated to such speeds gives off powerful radiation, called synchroton radiation (see Spectrum 129). The extraordinarily powerful synchroton radiation we observe from quasars is on the scale to be expected from a black hole scouring the centre of a galaxy cleaned of millions of stars. When there are no more stars left near enough to be swallowed, the quasars revert to the radiative power of ordinary galaxies. There are no quasars today because there is no matter left in the centres of galaxies to be swallowed by the black holes that lurk there. No other phenomenon is powerful enough to produce the quasar radiation.

But, says Rees, that is not the end of the story. Because the galaxies in which they are formed rotate, the black holes in their centres rotate, too. And because they are made of infinitely dense matter the black holes rotate virtually as fast as it is possible to rotate. They spin at near to the speed of light. Surrounding the centre of each galaxy is a magnetic field which is formed, predictably, in gas that is too far away from the black hole to have been sucked into it. The magnetic field in the centre of such a galaxy pulls on the spinning black hole, acting as a persistent brake upon it. When a brake is applied to any moving object energy is lost; one example is the heat given off when wheels are braked. When a brake is applied to a mass of a hundred million or so stars in a black hole spinning at a speed of near to 186 000 miles/second, we may expect the energy produced to be on an unfamiliar scale.

This energy, Rees proposes, is the explanation of the jets in the radio galaxies. The magnetic fields that surround the spinning black holes have narrow tunnels running through them to each side, perpendicular to the galactic plane, and the colossal energy produced from the braking effect of the magnetic field on the black hole is flung out through the tunnels. It emerges, shooting out through space, as jets of particles and radiation dwarfing the galaxy they come from.

Professor Rees believes that the evolution of galaxies into the quasar stage and onwards, with the formation of spinning black holes and radio jets, is probably a very common, perhaps almost universal process. Most galaxies, including our own, have gone through it. Spinning black holes may form from single stars as well as from millions of stars in the centres of galaxies. Single-star black holes would produce miniature radio jets. Two objects with structures that resemble or suggest the existence of such jets are known, namely the bright X-ray star Scorpio XI and the optically visible source SS433.



The double radio source 3C236. Contour lines map the intensity of the radio emission showing the source to have 'radio lobes' (at the bottom left and top right of the map) separated by 20 million light-years.

Violent Events

So this theory explains and links the three strangest phenomena in the known universe, black holes, quasars and radio jets. But it implies that we must look for the explanation of the most violent events in the visible universe in matter which can no longer be observed in that universe, in black holes. And if we are to predict the fate of the universe, say Rees and certain other astronomers, we must again take into account black holes and other categories of invisible matter.

It is possible for astronomers to calculate how much matter there would need to be in the universe for the gravitational forces pulling it together eventually to overcome the outward forces of expansion, so that the universe will eventually stop expanding and start to contract towards a Big Crunch. For this to happen, the universe in its present stage of expansion needs to contain an average of about three atoms rules out the crunch, because all the matter in the universe that has been observed by any kind of telescope adds up to only about one-tenth of one atom per cubic metre. But, says Rees, there is a lot of matter in the universe that we have not seen and can never see. And there is growing evidence that this invisible matter greatly outweighs the visible.

Some galaxies orbit around one another in pairs, like double stars. Their masses, calculated from their orbits, are estimated to be at least ten times that of their visible matter. This is still only one third of the mass needed to ensure a Big Crunch, but it does indicate that only about one-tenth of the matter in galaxies can be detected with any kind of telescope. Some of the rest may already have disappeared for ever into black holes. Perhaps as much as nine-tenths of the matter in the universe has gone that way. More invisible matter may be in the form of 'dark' stars, which have burnt out without collapsing into black holes but which no longer emit enough radiation to make them observable.

The amount of invisible matter which is present in a third form, particles called neutrinos, may dwarf that present in the visible universe.

In the first fraction of a second after the Big Bang, matter and its opposite, antimatter were probably created almost equally. They promptly annihilated

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each other, leaving a relatively small residuum, representing the margin of matter over anti-matter, to become the universe we see today. Particles called neutrinos were produced by each annihilation of particles.

Because neutrinos hardly ever interact with other particles, those formed just after the Big Bang have been flying around the universe ever since.

Until recently it was thought that neutrinos had so mass. Now some astronomers think that neutrinos do have mass and, although it is very small compared with the mass of other particles, there may be so many neutrinos that their combined mass dwarfs that of all other matter in the universe. It could be much more than enough to ensure a Big Crunch. The problem is how to detect neutrinos. Attempts to trap them, by burying detectors deep underground to screen out the impacts of other particles, have so far been unfruitful.

If these theories are correct, it is rather sobering to think of how unimportant our familiar universe of stars and galaxies is, compared with the invisible black holes which power all its most violent events and which may have already swallowed most of its matter, and with the invisible sea of neutrinos on which our familiar matter may float like trivial froth on the oceans.

(813S)

Video recording at over 600 miles per hour

Unique video coverage of the attempt on the World Land Speed Record by Richard Noble in his car 'Thrust 2' will be provided by cameras and video recorders from Sony Broadcast.

A lightweight video colour camera will be installed in the spare cockpit of the jet-powered car during the attemps to break the world record of 622 mph on the Bonneville Salt Flats in Utah, U.S.A.

Sony equipment is being used by Intervideo Productions Ltd. to record a documentary covering the 7 year development programme of 'Thrust 2', the people involved in the project and all the activities during the attempt in Utah. Three main camera teams will record the activities at base camp, the refuelling point at the end of the runway and from the air in a hot air ballon or a light aircraft. In addition, the camera installed in the car itself will provide dramatic shots of both the car's instrument panel and scenes of the runway as viewed by the driver.

To break the record, 'Thrust 2' has to make two passes over a measured mile, in opposite directions, within an hour. From standing start and acceleration through the measured mile and then deceleration will take something like 45 seconds over a distance of 10 miles. At the point of braking considerable G forces of up to 6.5 G will be experienced by the driver, but it is not yet known how the video camera and recorder will function under these conditions.

The camera's weight factor combined with the vibration from both the movement of the car over the salt flats plus high frequency vibrations from the Rolls Avon 403 jet engine (which produces some 17 tons of thrust) creates a very critical environment for both camera and recorder in terms of microphony.

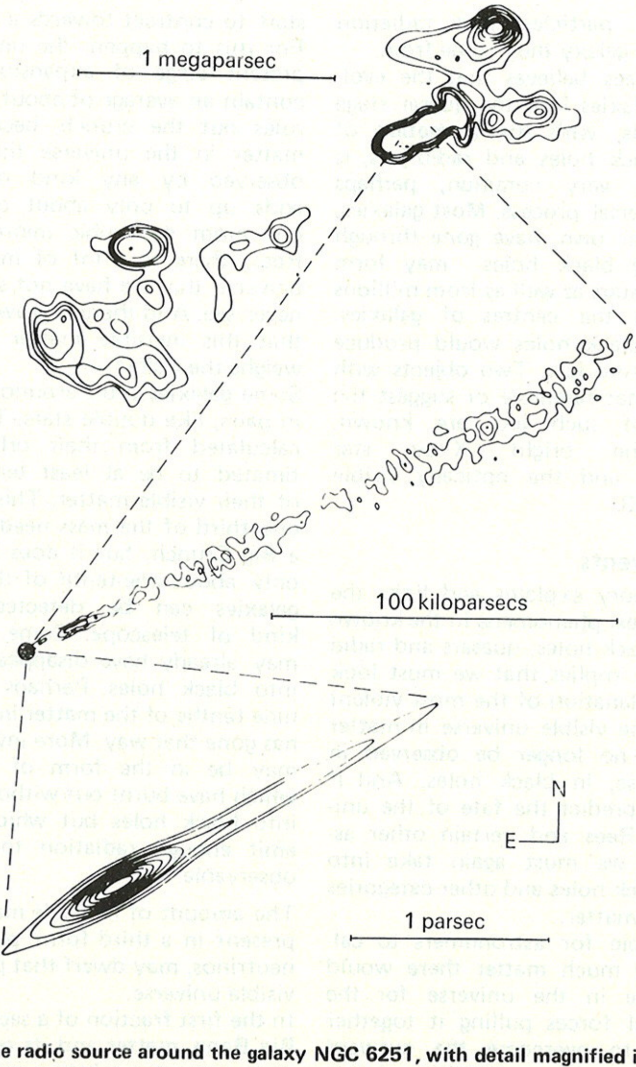
The weight of any item of equipment is multiplied by the G force applied. This means that the Sony camera, which weighs 10 lbs under normal gravity conditions, will have an actual weight of over 60 lbs on deceleration from 650 mph.

At present the camera is providing vital telemetry information on the behaviour of the car as well as an accurate record of the instrumentation read-out from the spare cockpit.

Richard Noble will be attempting to break the World Land Speed Record later this year at a speed in excess of 650 mph.

Sony Broadcast Limited

(806 S)



Structure of the radio source around the galaxy NGC 6251, with detail magnified in two stages. The parsec, a unit of stellar distance, is equivalent to 3·26 light-years.

selektor

DSB demodulator

carrier regeneration using the audio-frequency method

In the June 1982 issue we presented an article entitled "The principles behind an SSB receiver" and we hope that it provided answer to some questions. As a practical complement to the "Crash course in transmission and reception" we then presented a complete SSB short-wave receiver for home construction.

With this article we would now like to introduce another type of modulation that was mentioned: DSSC (double sideband, suppressed carrier) or, as it is more commonly known, DSB. An appropriate demodulator in a new circuit technique is provided for those who like to become more involved in DSB in future.

Conventional amplitude modulation (AM) with carrier should by now be quite familiar. Short-wave, medium-wave and long-wave listening is very common because all the problems of this type of modulation appear to have been solved by the invention of the detector receiver. Nevertheless, for widely varying reasons, the field of telecommunications has provided the impetus to 'invent' many other analogue and digital modulation methods; these are no doubt all justified but make quite different demands on the receiver.

Theory

Nobody really knows why DSB was not able to establish itself successfully. Some cynics tell us that vested interests in SSB carried more weight at the decisive moment. It is possible that the SSB technique was better developed at that time than the DSB technique. In any case, with respect to efficient use of transmitter power, the DSB technique represents a middle route between AM and SSB modulation (figure 1). If, for example, a sinusoidal carrier of a frequency of 4 MHz is modulated with a sinusoidal 'information signal' of a frequency of 1 kHz, two 'side frequencies' are produced in addition to the carrier frequency (3999 kHz and 4001 kHz). This can be proved mathematically but is beyond the scope of this article.

Figure 1 shows a modulated signal as displayed on a spectrum analyser. A spectrum analyser displays the amplitude or, in this case the power level of a signal, as a function of frequency and not as a function of time, as is the case with an oscilloscope. Assuming that the information signal does not consist of one frequency but of a mixture of frequencies, bands are obtained instead of lines in the spectrum of the modulated signal, one to the left and one to the right of the carrier. Both bands contain precisely the same information. The carrier contains no information but requires the most power, as can be seen in figure 1. If the carrier is then suppressed during transmission and the energy it contains is transferred to the information-carrying sidebands, the result is the two types of modulation DSB (DSSC) and SSB. The advantages and disadvantages of SSB were already discussed in the June 1982 issue. With DSB the effective, information-carrying power is doubled with respect to conventional AM. As with SSB, however, the carrier must be regenerated at the receive end. This is quite a challenge with respect to frequency stability of the demodulator.

At this stage we would like to present another example of DSB which we encounter daily whilst hardly noticing it. We are referring to the stereo signal from the VHF receiver. Advanced radio enthusiasts will immediately point out that VHF radio operates with FM. This is true, but let us examine the stereo signal. It consists of the frequency band L+R, the pilot tone and two L−R bands around the 38 kHz subcarrier. The carrier is modulated with the L−R signal in DSB technique. Thus the carrier is initially missing in the receiver. The entire signal is finally frequency-modulated with the RF carrier. To avoid any misunderstandings, we are not designing a new type of stereo decoder here, but merely wanted to provide an example of DSB!

Block diagram

Figure 2 shows the block diagram of a DSB superhet receiver. The input signal is mixed with an oscillator signal. The output of this oscillator is somewhat higher in frequency than the input signal and is tuned simultaneously with the input signal. In this way the frequency difference between input signal and oscillator signal remains constant over the entire tuning range of the receiver (455 kHz in this example). The 'difference signal' is known as the IF (intermediate frequency).

The output signal of the IF amplifier is applied to the input of the DSB demodulator. Mixing then takes place here too, but this time with a square-wave signal from the sampler. The result is an audio-frequency signal from which the carrier (now an AF carrier) is regenerated with relatively simple means. If this carrier is then mixed with the IF signal previously obtained by subtractive mixing, the AF signal is presented at the output. The frequencies given in figure 2 relate to the example in figure 1.

The term 'sampler' that appears twice instead of oscillator is not really relevant in our case. We are more concerned with carrier regeneration than with the details of AM reception.

The mathematics of the method are complex and involve many trigonometric formulae. The result is straight-forward, however: if two sinusoidal signals, like the 'side frequencies' that we have already met, are multiplied, the carrier is produced with twice the frequency together with some other frequencies which are filtered out.

Practice

In contrast, the method is clearer in practice. Multiplication of two sinusoidal signals is normally performed using a 4-quadrant multiplier (ring modulator). We will use a simpler method, however. Since a perfectly sinusoidal signal is not needed at the output, digital multiplication can also be employed. This merely requires an exclusive-OR gate; the original signal and the out-of-phase signal are applied to its inputs. With a phase shift of 90° a square-wave signal appears at its output with twice the frequency of the input signals. This type of phase-comparator, exclusive-OR gate can therefore also be described as a digital 4-quadrant multiplier.

Figure 3 shows the circuit of the DSB demodulator which we shall now examine step-by-step. T2 performs the function of the second mixer in the block diagram. The corresponding sampler consists of the oscillator with Fi1 and T3 and switch T4. All types of filter which can be tuned to 455 kHz can be used.

Although the first stage of the demodulator still operates at high frequency, it is followed by audio-frequency stages. The IF signal obtained by subtractive mixing is applied to a potent amplifier via buffer A1. The signal is then amplified until 'clean' square-wave signal is present at the output of comparator A3. The phase-shift mentioned is performed by integrator A4. It is configured so that this phase-shift takes place between approximately 10 and 30 kHz. The 'shifted' signal is shaped into a square-wave signal by comparator A5. Exclusive-OR gate N1 forms the digital 4-quadrant multiplier. Ignoring for a moment the PLL circuit IC5, the frequency of the output signal of N1 is then divided down by FF1 to the frequency of the carrier. The low-pass filter consisting of R20/P3 and C19 compensates for the 90° phase-shift caused by the PLL circuit (45° at $f_{vco}/2$). Comparator A6 forms a square-wave signal from the audio-frequency carrier.

The third mixer mainly consists of T5. Two signals are applied to it: the audio-frequency IF signal via low-pass network R12/C10 and the signal from the sampler consisting of FF2 and N2 . . . N3. This circuit may appear a little strange at first sight, but it is really not complicated. It consists of a monostable that is triggered by the audio-frequency carrier. If a positive pulse appears at pin 11 of FF2, output Q becomes a logic 1. After passing through the delay circuit of N2 . . . N4 a pulse appears at differentiating networks C20/R21, but the flip-flop is simultaneously reset and waits for the next triggering

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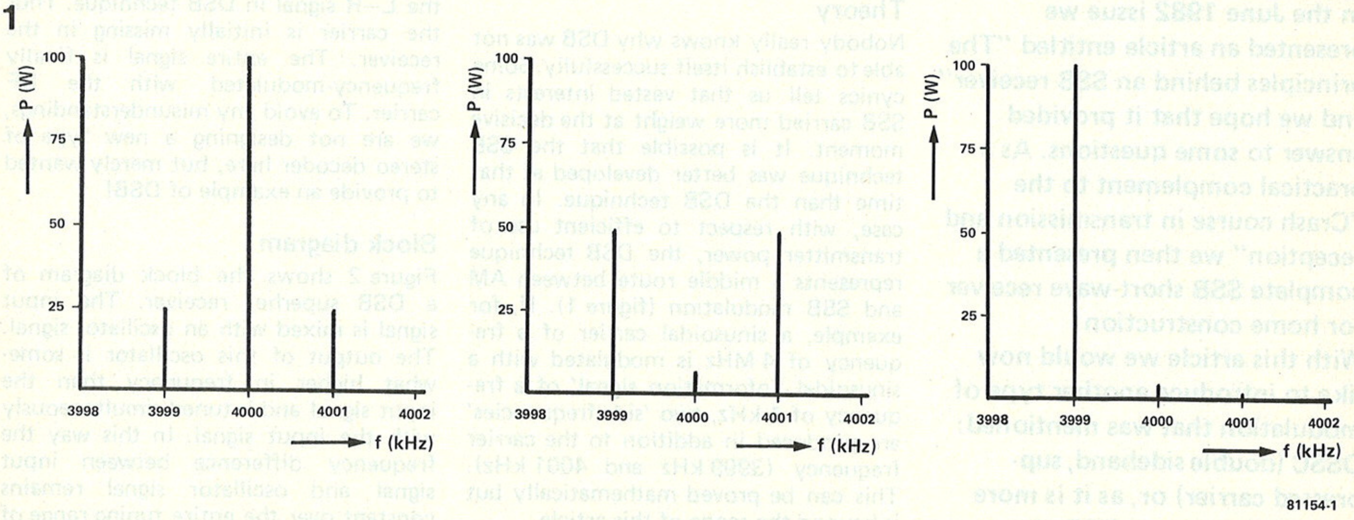

Figure 1. Frequency spectrum of a 4 Mhz carrier modulated with a 1 kHz signal in AM (1a), DSB (1b) and SSB (1c). All signals are sinusoidal.

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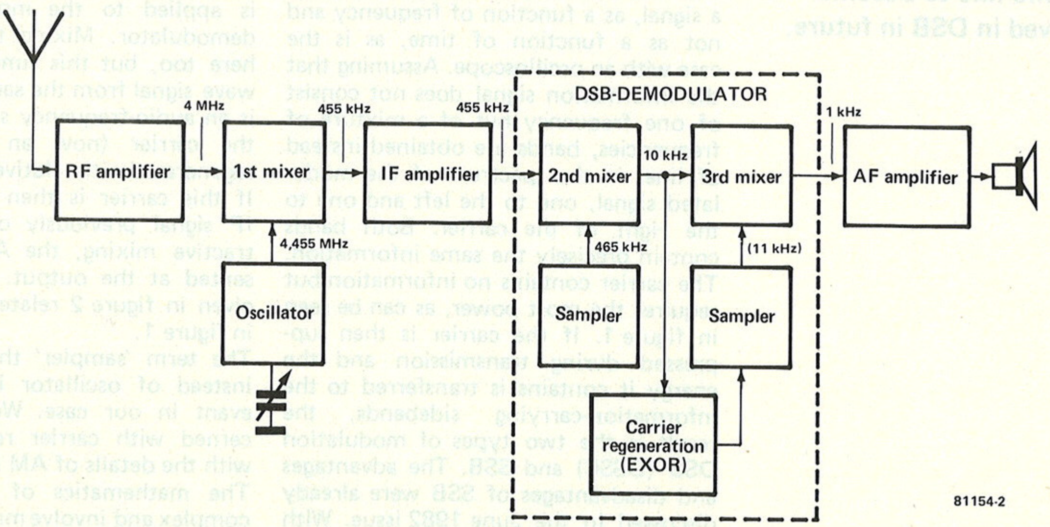


Figure 2. Block diagram of a DSB receiver. The demodulator chiefly consists of two mixers and a circuit for carrier regeneration with triggers the sampler of the second mixer.

3

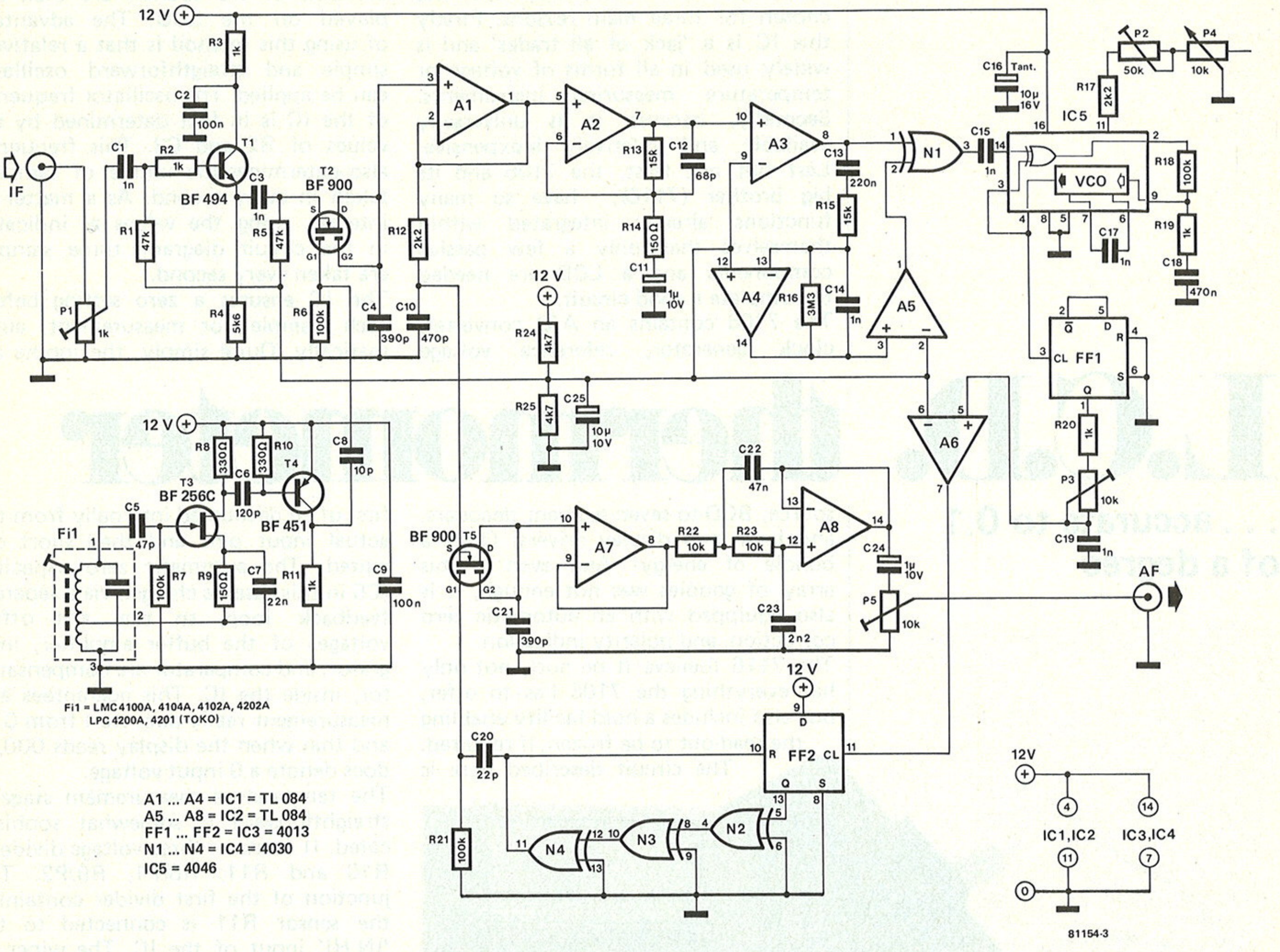


Figure 3. The circuit of the DSB modulator mainly operates in the AF range. For this reason, operational amplifiers and CMOS-ICs are utilized for carrier regeneration and the second mixer. The PLL IC operates as a frequency stabilizer and carrier-buffer.

pulse. During this period T5 conducts; the weighted signal is fed to the active low-pass circuit of A8 via buffer A7 and the audio-frequency signal is present at the output (wiper of P5).

The PLL circuit of IC5 performs two functions. Firstly, of course, it allows a frequency to be 'locked on' very precisely. Secondly, this frequency is also retained when the control voltage for the VCO has become very low. In our case this signifies the following: when viewed on an oscilloscope the DSB signal looks like beads on a string. One would expect the carrier to be at the points of contact between the beads, but there are none. Since the amplitudes of the signals from the mixture of frequencies of the sidebands are very low in this range, the demodulator does not really 'know' whether a useful signal is present. In could simply be noise. Thus, in a manner of speaking, the PLL circuit buffers the generated carrier under conditions of fading field strength, so that the carrier does not disappear again.

Application and alignment

The DSB demodulator can be utilised in any AM superhet receiver. Since the second mixer is a 'harmonic' type, an IF signal in the range of 455 kHz to approximately 20 MHz can be processed. Figure 2 shows the general configuration. The only stage still required at the output of the demodulator is an AF amplifier. Clearly the demodulator also provides advantages in conventional AM reception.

Alignment does not involve any problems, because the audible method is used. First connect the AF amplifier to the output of A1. Tune the receiver to a conventional AM transmission (with carrier) so that a signal is present at the output of the IF amplifier. Adjust the core of Fi1 so that the whistle in the loudspeaker is just at the audible frequency limit (about 15 kHz). If this tone sounds distorted, the mixer is being overdriven. In that case P1 should be adjusted so that the whistle is barely undistorted.

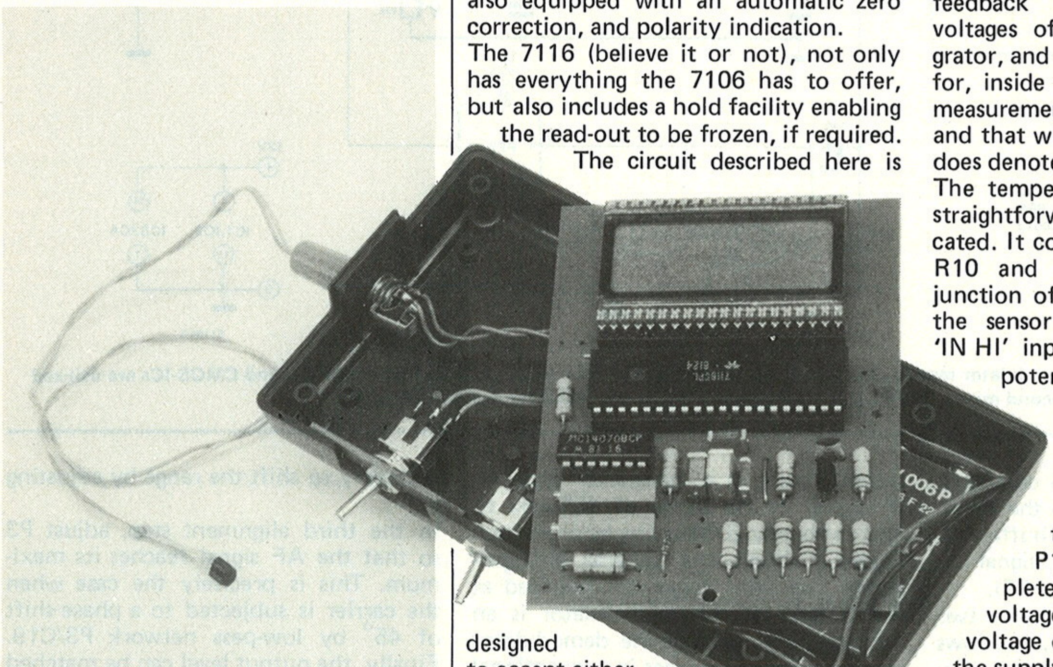
In the second alignment step, connect the AF amplifier to its real location in the circuit, i.e. to the wiper of P5. Set P2 . . . P5 to their middle positions. Then adjust P4 so that the PLL circuit 'locks on'. When a transmission is received, i.e. when modulation is present, (the whistle should cease when the circuit locks on). It may be necessary to shift the range by adjusting P2.

In the third alignment step, adjust P3 so that the AF signal reaches its maximum. This is precisely the case when the carrier is subjected to a phase-shift of 45° by low-pass network P3/C19. Finally, the output level can be matched to the following amplification stage by adjusting P5. The entire alignment process should be repeated several times. In particular, the distortion caused by selective fading should cease. Instead a kind of phasing effect appears.

One thing becomes clear from the description of the alignment process: if the demodulator does not precisely 'lock on' to the transmission, an unpleasant howling and whistling is heard from the loudspeaker. For this reason, one should tune twice: first in the normal manner with the existing detector and then precisely with the demodulator described here. The only additional controls required on the receiver are a changeover switch and a potentiometer. We hope that this circuit will contribute to an improvement in your short-wave reception. ◀

L.C.D. thermometer

. . . accurate to 0.1 of a degree



During the past few months, the Elektor offices have been inundated with requests for a digital thermometer.
In answer to all these requests, and to relieve the pressure on our technical queries department, we present a digital circuit using a special IC and a LCD display. The design is inexpensive, but, nevertheless accurate, precise, and has a very low power consumption! The range of the instrument is from –50°C to +150°C. The temperature is displayed 0.1 degree at a time, therefore making it suitable for practically any application.

The 7106 is a well known IC in the world of A/D converters, and was chosen for three main reasons. Firstly this IC is a 'jack of all trades' and is widely used in all forms of voltage or temperature measuring instruments. Secondly, because it is universally available and relatively inexpensive. Last but not least, the 7106 and its big brother (7116), have so many functions already integrated within themselves that only a few passive components and a LCD are needed to complete a good circuit.

The 7106 contains an A/D converter, clock generator, reference voltage source, BCD-to-seven-segment decoders, and latch and display drivers! Quite a bundle of energy! And even if this array of goodies was not enough, it is also equipped with an automatic zero correction, and polarity indication.

The 7116 (believe it or not), not only has everything the 7106 has to offer, but also includes a hold facility enabling the read-out to be frozen, if required. The circuit described here is designed to accept either IC, allowing the constructor to decide which of the two he prefers to use.

The circuit diagram

The circuit as shown in figure 1 is really nothing more than a digital voltmeter, which in turn measures the voltage drop across a temperature sensor.

The dual slope conversion principle is applied for the voltage measurement. Basically the input voltage from the sensor charges capacitor C4 for a fixed period of time. The capacitor then discharges, the rate at which the capacitor is discharged being determined by the reference voltage. The actual time it takes for the capacitor to discharge fully (return to zero) is then proportional to the input voltage level. During the discharge period, pulses from an oscillator are stored in a counter, obviously the number of pulses dependant upon the time. In turn the contents of the counter are then displayed on the LCD. The advantage of using this method is that a relatively simple and straigthforward oscillator can be applied. The oscillator frequency of the IC is in fact determined by the values of R2 and C3. This frequency also determines the number of 'samples' taken in every second. As a matter of interest, using the values as indicated in the circuit diagram, three samples are taken every second.

The IC ensures a zero setting before each 'sample', or measurement, automatically. Quite simply, the inputs are first of all decoupled internally from the actual input pins and then short circuited. The automatic zero capacitor (C5 in this case) is charged via a separate feedback loop, so that the offset voltages of the buffer amplifier, integrator, and comparator are compensated for, inside the IC. This guarantees any measurement really does start from 0 V, and that when the display reads 000, it does denote a 0 input voltage.

The temperature measurement stage is straightforward if somewhat sophisticated. It contains three voltage dividers: R10 and R11; R8/P1; R9/P2. The junction of the first divider containing the sensor R11 is connected to the 'IN HI' input of the IC. The wiper of potentiometer P1 is linked to the 'IN LO' input and the wiper of P2 to the 'REF HI' input. In effect the circuit measures the differential voltage between one side of the sensor and the wiper of P1. Any measurement is completely independant of the supply voltage level, because the reference voltage of the IC is also derived from the supply (via the divider R9/P2). Keep in mind that a full scale readout will be equal to twice the reference voltage. Any decrease in supply voltage will not change the readout, because the reference voltage will decrease by the same amount (when compared with the measuring voltage that is). Resistor R4 and capacitor C6 act as a input smoothing filter.

The display is driven directly by the IC. The EXOR gate N2 ensures that the decimal point is activated, by supplying the inverted backplane signal to the corresponding LCD points.

The circuit also has a low battery indication function. The display denotes this by either an arrow or the term 'Low Bat'. An EXOR gate also controls this function!

Transistor T1 is used as a supply voltage level detector. The emitter is connected to the junction of R5 and R7, and its base to the test connection of the IC. This pin not only allows the display

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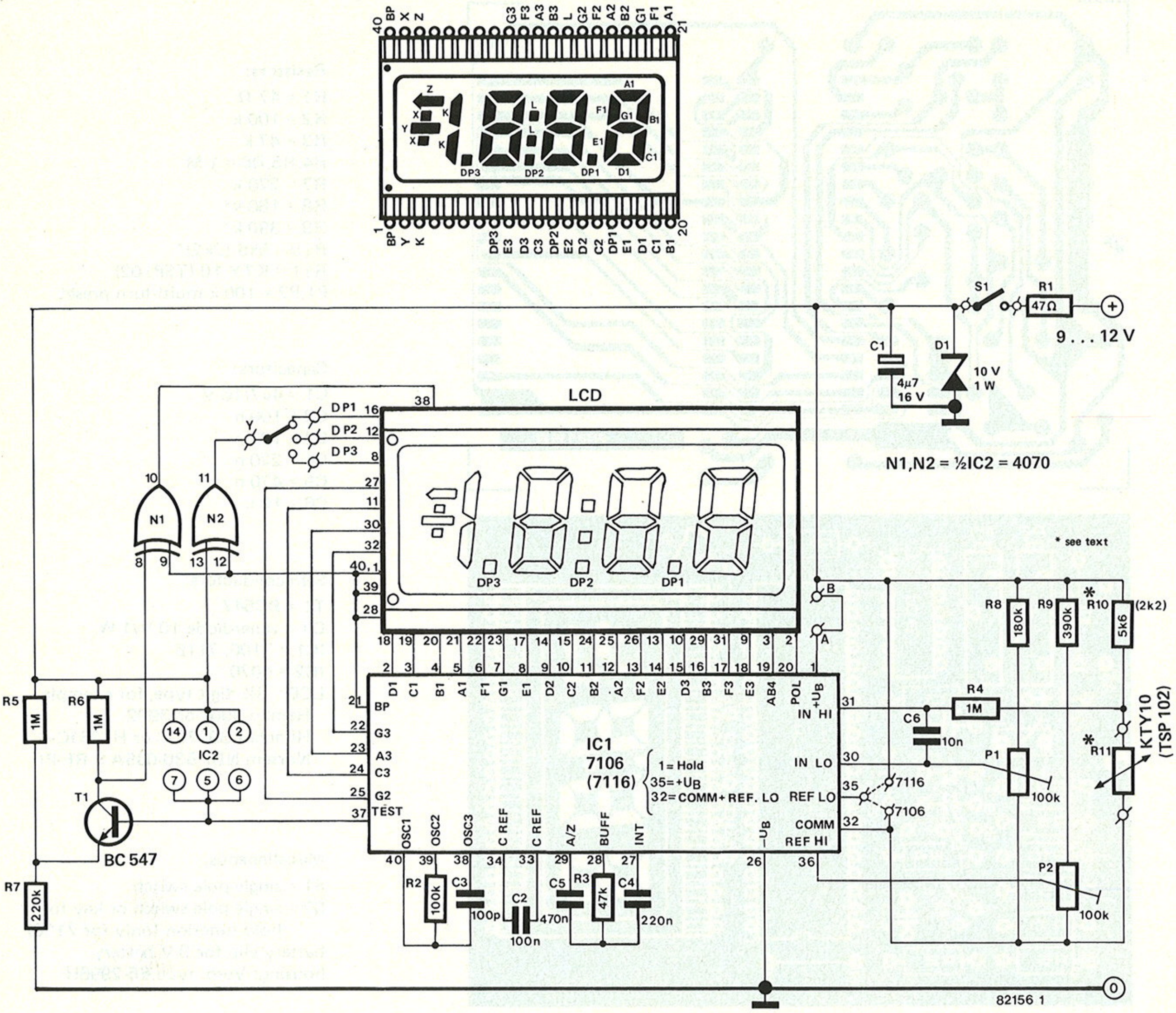

Figure 1. The circuit diagram of the digital thermometer. The circuit is compact, consisting of two ICs and a few surrounding components. A 9 V battery supply is ideal.

itself to be tested (by connecting it to a +5 V supply), but, moreover can provide us with a positive stabilised d.c. voltage! By choosing the right ratio between R5 and R7, T1 will cutoff the moment the supply voltage drops below 7.2 V. As a result the collector voltage of T2 increases, causing N1 to activate the correct notation on the display.

A 9 V battery such as a PP3 is quite sufficient, since the circuit consumes only a few milli-amps. A mains supply is also possible, and it is for this reason that R1 and the zener D1 are added to the circuit.

The temperature sensor

There are various types of sensors on the market, and the only reason we have picked two particular ones, is that they are inexpensive.

Original tests showed the KTY 10 from Siemens to be ideal, but, as this can be difficult to get hold of, we also tried the TSP 102 manufactured by Texas Instruments which worked well. Most of the types looked at consisted of a silicon plate, whose resistance depended on the temperature. The only real difference between types was their temperature range. The KTY10, for instance ranged from −50°C to +150°C, whereas the TSP was effective over a range from −55°C to 125°C. The first version has a nominal resistance of 2000 Ω at 25°C and the TSP 1000 Ω again at 25°C. The temperature coefficient was 0.75%/°C and 0.7%/°C respectively. These last figures denoting the resistance increase, per degree celcius, as a percentage over the nominal value.

The accuracy of the circuit is mainly dependant on the width of the measuring range. Which type to use is left to the discretion of the constructor. A serial resistor (R10) is applied (in series with the sensor) in order to stabilise the linearity of the sensor, especially when small measuring ranges are required. Table 2 provides a summary of several ranges, with the linearity error, and serial resistor values needed. Table 3 describes, in detail, the differing sensors, together with their housing dimensions and type numbers.

Construction

Figure 2 illustrates the specially designed printed circuit board of the circuit.

The dimensions of the board and the way that the components have been grouped together allow the completed circuit to fit into a case manufactured by Vero (type Nr. 65-2996H). Provision has been made for all the components to be mounted onto the printed circuit board. Constructors should make sure that low profile sockets are used for IC1, IC2 and the display. The display can be inserted into a 40 pin socket which has been sawn in half. We also advise the use of good quality multi-turn presets. As with anything made of glass, great

2

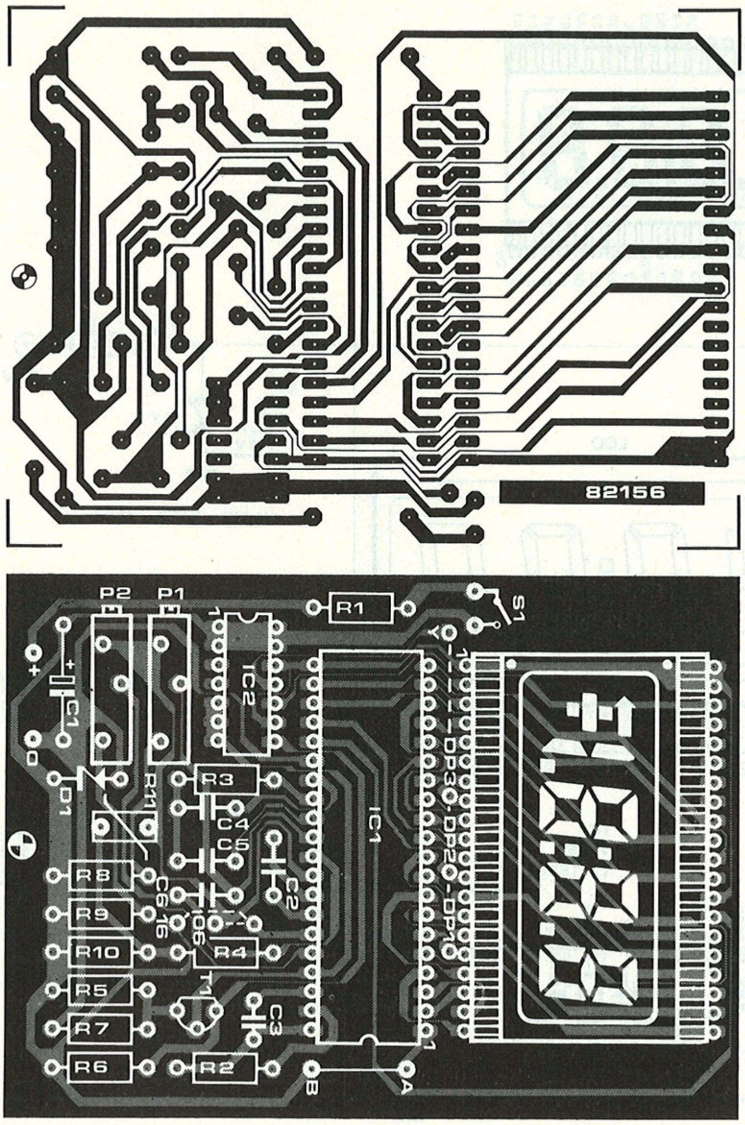

Figure 2. The track pattern and component layout of the printed circuit board. The size and layout of the board allows the completed circuit to be inserted into a ready made plastic case by Vero. Ensure the correct wire links are in place for the 7106 or 7116.

parts list

Resistors:
R1 = 47 Ω
R2 = 100 k
R3 = 47 k
R4,R5,R6 = 1 M
R7 = 220 k
R8 = 180 k*
R9 = 390 k*
R10 = 5k6 (2k2)*
R11 = KTY 10 (TSP102)
P1,P2 = 100 k multi-turn preset

Capacitors:
C1 = 4µ7/16 V
C2 = 100 n
C3 = 100 p
C4 = 220 n
C5 = 470 n
C6 = 10 n

Semiconductors:
T1 = BC547
D1 = zenerdiode 10 V/1 W
IC1 = 7106, 7116
IC2 = 4070
LCD: 3½ digit-type, for example
Hamlin 3901 or 3902
Hitachi LS007C-C or H1331C-C
Norsem NDP 530-035A S-RF-PI

Miscellaneous:
S1 = single pole switch
S2 = single pole switch or key for hold function (only for 7116)
battery clip for 9 V battery
housing: Vero, type 65-2996H

* metal film is preferred

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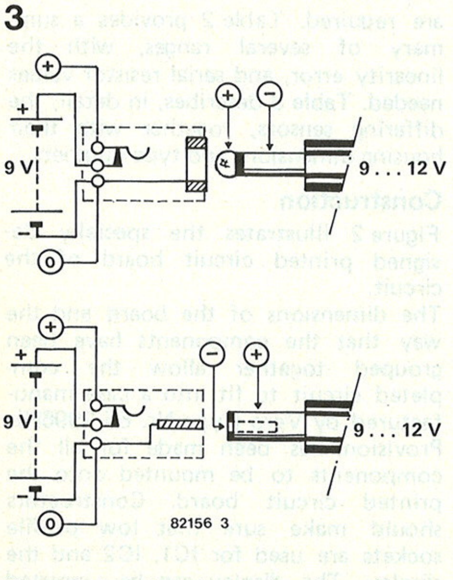


Figure 3. An external power supply can be connected as shown. The battery is automatically switched off when the plug is inserted.

care should be taken when handling the display, especially when inserting it into its socket. Too much pressure on the glass plates may cause the display to appear internally smudged, permanently!

When using the circuit as a normal thermometer, the decimal point DP1 should be connected to point Y by means of a wire link. Obviously, depending on the application, the decimal point can be moved around, by using a rotary or slide switch, if required.

As already stated earlier, the circuit is designed to take either the 7106 or the 7116. For the 7106 wire links are required across points A and B and 06, as shown on the component overlay illustration of the printed circuit board. In the case of the 7116, link 06 is removed and replaced with a link on points '16' Should you then require the ability to freeze (hold) the display reading, link AB has to be replaced with a simple on/off press button switch. Keep in mind that this facility is not available when using the 7106.

The sensor can be connected to the circuit by means of ordinary insulated wire, the length of which is not critical. In fact anything up to 30 metres is possible without difficulty. For reliability we suggest encapsulating the soldered connections of the sensor with epoxy resin or glue.

A PP3 type 9 V battery is ideal for the power supply, as it has the advantage of fitting nicely into the battery compartment of the Vero case.

Constructors wishing to feed the circuit from the mains, can install a miniature supply socket next to the battery, to cater for a 9 V mains adapter. Figure 3 clearly illustrates how this should be wired. The battery supply will be automatically cut off immediately a power plug is inserted.

A single bolt or screw with a spacer ensures the circuit is firmly fixed into the case. A piece of clear perspex in the window of the case will protect the

Table 1

Nominal resistance value of the several types

new indication KTY10

suffix	resistance value at 25°C
−3	1910 Ω ± 1%
−4	1940 Ω ± 1%
−5	1970 Ω ± 1%
−6	2000 Ω ± 1%
−7	2030 Ω ± 1%
−8	2060 Ω ± 1%
−9	2090 Ω ± 1%

old indication KTY10, KTY11-1, KTY11-2

suffix	resistance value at 25°C
A	2000 Ω ± 1%
B	2000 Ω ± 2%
C	2000 Ω ± 5%
D	2000 Ω ± 10%

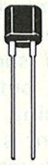
TSP102, TSF102, TSU102

suffix	resistance value at 25°C
F	1000 Ω ± 1%
G	1000 Ω ± 2%
J	1000 Ω ± 5%
K	1000 Ω ± 10%

Table 3

Housings of the several types

A

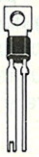


KTY10, TSP102

The housing most frequently used. The setting time is 30 s to 63% of the final value and 150 s upto 99% in silent air.

Housing A

B

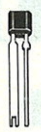


KTY11-1, TSF102

This is a smaller version with screw connection. The settable time is 7 s to reach 63% of the final value.

Housing B

C



KTY11-2, TSU102

The same case as housing B, but without screw fastening

Housing C

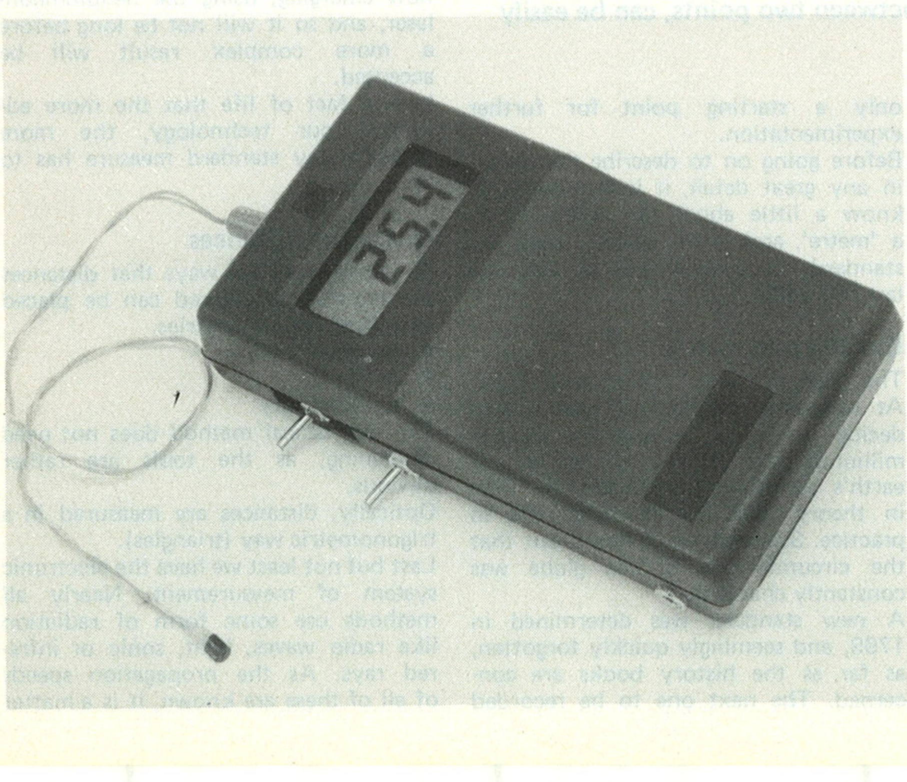
Table 2

Serial resistance for KTY sensors

temp. range	R_{series}	lin. error
−20 . . . + 40°C	5k6	+0,08 . . . −0,04°C
+40 . . . +100°C	8k2	+0,03 . . . −0,02°C
+60 . . . +140°C	10 k	+0,07 . . . −0,04°C
−20 . . . +130°C	6k8	+0,6 . . . −0,6°C
−50 . . . +150°C	6k8	+1 . . . −1°C

Serial resistance for TS . . . 102 sensors

temp. range	R_{series}	lin. error
−25 . . . + 45°C	2k2	- - -
0 . . . +100°C	2k6	+0,05 . . . −0,07°C
−55 . . . +125°C	2k5	+0,3 . . . −0,2°C



display. The switches, sockets and so forth can be mounted in the power part of the housing.

The current consumption of the circuit when using the most commonly available sensor (TSP102) is only 2 mA.

Several sensors, which are activated consecutively by a separate switch can also be used. To do this correctly, sensors have to be selected for equality, otherwise errors in measurement readings will occur.

Calibration

Perhaps we have been a little too quick to explain how to install the circuit into the case, because first of all it has to be calibrated.

Initially the sensor has to be placed into a small cup of chopped melting ice. The cup should contain more ice than water, and the water must cover the ice completely. Give the sensor time to react (about 5 minutes), and turn P1 until the display reads 00.0. P2 sets the scale factor. How this is adjusted depends on the measuring range required. For lower temperatures (−25°C to +45°C), P2 can best be calibrated using a normal thermometer. Insert both thermometers into a bowl of water having a temperature of around 36 . . . 38°C, give the sensor a little time to react, and then set P2 so that the reading on the display corresponds.

Higher measuring ranges can be calibrated by suspending the sensor in boiling water, and then adjusting P2 until the readout is 100°C. The only critical aspects of this procedure are to ensure that the water really is boiling and that the sensor does not touch the sides, or bottom of the kettle.

Finally as you have completed the circuit, why waste the hot water. Make a nice cup of tea and relax.

ultrasonic distance measurement

a good starting point for experimentation

There are several ways to measure distances. The method adopted depends not only on what is being measured, but also on your occupation.
The circuit described utilises ultrasonic sound, working on the principle that as, sound travels through the air at a known speed, the time taken and therefore the distance travelled between two points, can be easily determined.

Measuring distances is not difficult, especially when the right equipment is available. Modern technology has certainly done away with the old comical approach of measuring the shelf size by spreading your arms out. For short distances a simple ruler will do, but, in surveying, everything from, chains, theodolites, and sonic equipment is used.

The main advantage of using ultrasonic sound is, that the need for any mechanical parts is completely eliminated, simplifying construction considerably.

In practice we found the circuit to be accurate upto about 10 metres, which is very good considering the circuit is only a starting point for further experimentation.

Before going on to describe the circuit in any great detail, it is interesting to know a little about the definition of a 'metre', and in the various ways the standard has been arrived at over the last 300 years.

Exactly one metre

The 'metre' started life around 1792. At sometime during that year it was decided to define the standard as: one millionth part of one quarter of the earth's peripheral circumference. Fine in theory, but, totally inaccurate in practice. Scientists soon found out that the circumference of the globe was constantly changing.

A new standard was determined in 1799, and seemingly quickly forgotten, as far as the history books are concerned. The next one to be recorded and kept to appeared in 1889, a mere 90 years later. This was made of a mixture of platinum and iridium. It is this reference standard which can be seen in Sevres, near Paris. Rumour, at the time, gave the idea (unjustifiably) that the standard was based upon the hight of Napoleon II and as his stature was diminishing with every military defeat, it could not be accepted. For whatever reason (perhaps best left unsaid) the rest of the world continued to search for a more accurate standard. As most of you are aware one particular country in europe (remaining nameless), took nearly 300 years to even come to terms with the fact that a metre even existed.

At the beginning of the twentieth century, scientists started to look at the possibility of using the wavelength of light to define the metre. Consequently the cadmium lamp became the international standard for spectroscopy in 1927. For the uninitiated, this means the study, measurement, and analysing, of rays, light and other phenomena by optical means. The actual unit of length was defined as the Ångström ($1\ \text{Å} = 10^{-10}$ m). Even this was not good enough for certain applications, although it is still used as a secondary definition.

The modern standard was established in 1960 using the wavelength of a krypton lamp, which as a matter of interest was not supplied by the famous strip cartoon gentleman.

The metre is defined as equaling 1650763,73 wavelengths of radiation (measured in a vacuum) released by Krypton isotope 86KV during its transition between $2p_{10}$ and $5d_5$. The multiplication factor remained, because scientists still wished to relate the new standard to the old original one.

A new way of defining the standard is now emerging, using the helium-neon-laser, and so it will not be long before a more complex result will be accepted.

It is a fact of life that the more advanced our technology, the more accurate any standard measure has to be.

Measuring distances

To summarise, the ways that distances are normally measured can be placed into three main catagories.

- mechanically
- optically
- electronically

The mechanical method does not need explaining, as the tools are rather obvious.

Optically, distances are measured in a trigonometric way (triangles).

Last but not least we have the electronic system of measurement. Nearly all methods use some form of radiation like radio waves, light, sonic or infrared rays. As the propagation speeds of all of these are known, it is a matter

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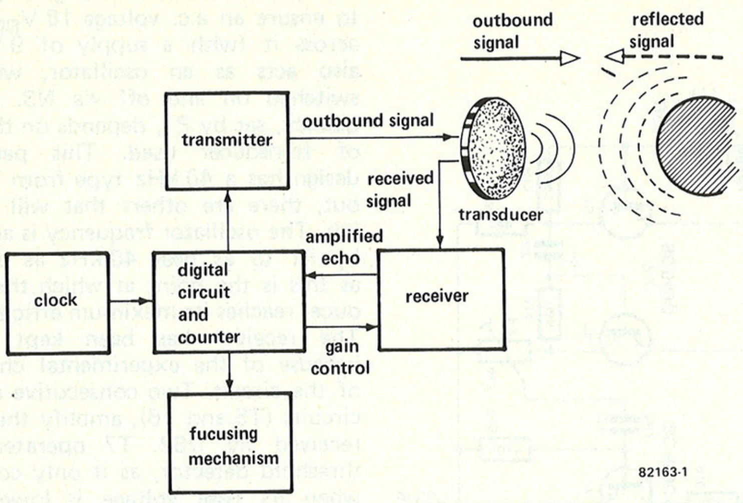

Figure 1. The circuit diagram of a system for measuring distances developed by Polaroid, operating with ultrasonic sound. An ultrasonic pulse is transmitted by a transducer, which then receives the reflected signal. The digital parts of the circuit convert the time taken for the transmitted pulse to travel to and fro, into distances. It then adjusts the camera lens to bring it into focus.

of determining the time taken for a waveform to travel between two points. Infra-red radiation is mainly used for great distances (a number of miles), as it is relatively simply to modulate.

Electronic equipment has been used to measure distances of 60 miles and above, but the effectiveness of such systems depends on a number of factors, such as atmospheric conditions, visibility and so on.

With the advent of space technology, lasers are used in combined electro-optical systems to determine the hight at which satellites are orbiting the earth.

In practice

All the methods so far described are mainly used to measure great distances. The average man in the street, certainly does not require sophisticated equipment to decide the size of his living-room carpet, unless of course he lives in a mansion house or castle.

There is one popular hobby in which the accurate measurement of distances is very important; photography! As we all know, it is essential to determine the exact distance between the subject being photographed, and the camera, otherwise the lens cannot be adjusted correctly for focus. The industry supplies quite a lot of aids and equipment which overcomes this problem.

Most cameras utilise some form of optical trigonometric system, with two or more indicators within the view finder which have to be aligned by rotating the range adjustment of the camera. Reflex cameras for instance, use a complex network consisting of a fronted glass, a wedge frame and tiny prisms.

During the last few years, a number of manufacturers have introduced the automatic focusing camera. Quite a few employ a system of mirrors and prisms, with an electric servo motor moving the lens accordingly. Some are even equipped with an infra-red LED and lens enabling the camera to be automatically focused at night.

A recent development, worth a closer look is the new sophisticated system introduced by Polaroid.

The Polaroid system

When considering automatic focusing cameras, the Polaroid system is something really special, in as much as it is the only one using ultrasonic sound. A large honey-comb patterned gold coloured disc on the outside of the camera casing acts as the transducer (transmitter/receiver) for the sonic pulses.

Figure 1 illustrates the actual distance meter contained within the camera.

The transducer sends out a 'burst' of 1 ms duration. This consists of a series of pulses each having a different frequency, four to be precise (60, 57, 53 and 50 kHz). The reason for so many frequencies is that it is possible for a particular frequency to be absorbed, rather than reflected, by the subject being photographed. The chance of this happening depends on the shape and material of the topic. So, rather than putting all the eggs in one basket, by transmitting four frequencies, the reflection of at least one is ensured.

The transducer then switches over to reception immediately the burst has been transmitted. The reflected signal it receives is then amplified and fed to a digital circuit which determines the time interval between transmission and reception. The circuit processes the signal and in turn controls a servo mechanism, which adjusts the lens to the correct focus setting. The gain of the receiving amplifier can be varied (in 16 steps), dependant on the distance the signal (burst), has had to travel. Obviously the greater the distance between camera and subject, the weaker the signal.

The system is proven and therefore functions well and accurately. It is effective up to a maximum of 10 metres, which is more than sufficient for normal photographic purposes.

The ultrasonic distance meter

The Elektor design team have combined their thoughts, together with the ideas contained in the Polaroid innovation to come up with an ultrasonic distance meter.

As mentioned earlier sound, ultrasonic or otherwise has a known speed through air. Therefore the time taken to travel from transmitter to subject and back again can be used to determine the distance. The transmitted 'burst' supplies a start pulse to a counter which operates at the same frequency as the propagation speed of sound in cms per second. The received reflected signal provides the stop pulse. The counter would therefore give the distance over which the Burst has travelled. This value would obviously be twice the distance between the object and the transmitter, so, a simple division by two would give us the correct answer.

Figure 2 illustrates in block diagram form what we have just described; transmitter, receiver, counter with readout, and an oscillator switched on and off by the transmitted and received pulses.

The circuit diagram

The circuit diagram of the complete circuit is shown in figure 3. The transmitter consists of gates N1 and N2, which together form a bridge circuit. The ultrasonic transducer US1 is con-

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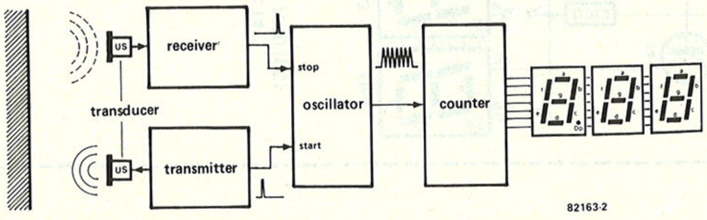

Figure 2. The block diagram of the ultrasonic distance meter. An oscillator starts sending pulses to a counter, when the ultrasonic 'burst' is transmitted. The received pulse stops the oscillator, so that the number of pulses counted indicate the distance measured, (assuming that the correct oscillator frequency was used).

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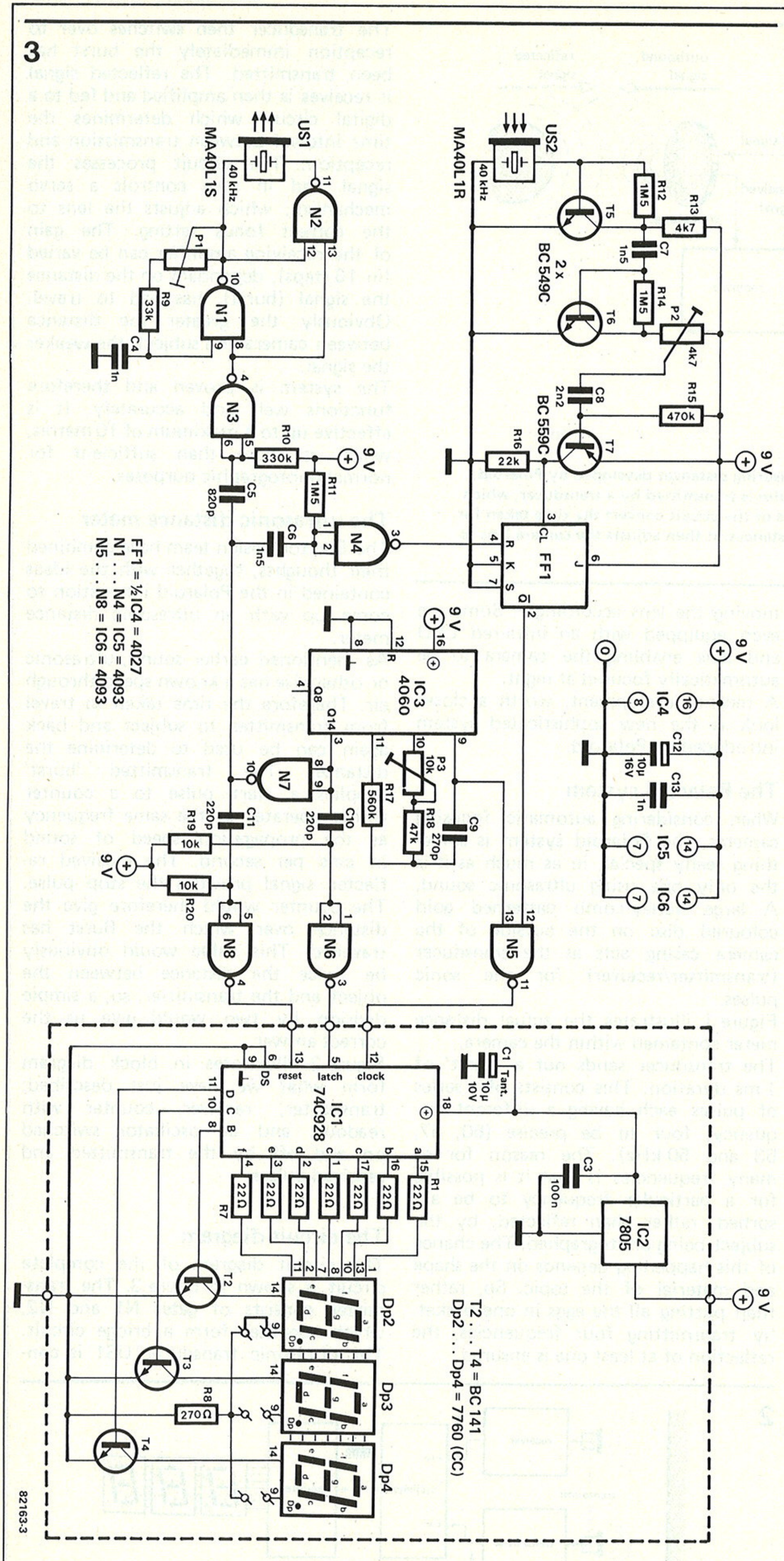

Figure 3. The circuit diagram of the distance meter. The receiver stage is situated at the top left hand side with the transmitter immediately below it. Within the dotted section on the right is the counter and display. The oscillator is constructed around IC3.

nected between the two gate outputs to ensure an a.c. voltage $18\ V_{pp}$ exists across it (with a supply of 9 V). N1 also acts as an oscillator, which is switched on and off via N3. Its frequency, set by P1, depends on the type of transducer used. This particular design has a 40 kHz type from TOKO, but, there are others that will do the job. The oscillator frequency is adjusted by P1 to as near 40 kHz as possible as this is the point at which the transducer reaches its maximum efficiency.

The receiver has been kept simple because of the experimental character of the circuit. Two consecutive emitter circuits (T5 and T6), amplify the signal received by US2. T7 operates as a threshold detector, as it only conducts when its base voltage is lower than the supply (–6 V). To put it another way; T7 conducts when the a.c. voltage (measured at the wiper of P2) exceeds $1.2\ V_{pp}$. A further oscillator is constructed using IC3 and its surrounding components (R17, R18, P3 and C9). IC3 is in fact a 2^{14} divider with built in oscillator.

The frequency is set to 17190 Hz using P3, since the speed of sound is 343.8 m/s at a temperature of 20°C;

$$\frac{34380\ (\mathrm{cm/s})}{2} = 17190.$$

The 2½ digit DVM published in our February 1981 issue is used as a counter with readout. IC1 (counter, latch and display control) directly drives the displays Dp2 . . . Dp4, which are multiplexed by IC1 via transistors T2 . . . T4. IC2 feeds a stabilised 5 V supply to the counter and display stage of the circuit. IC1 is able to drive 4 displays, but Dp1 and T1 (from original DVM circuit), are omitted, as only three are required here.

Nearly all the other components in the circuit are needed to synchronise the various stages. The importance of correct timing is illustrated in figure 4. This denotes the differing pulses and frequencies present at various points in the circuit.

With an oscillator frequency of 17190 Hz, output Q14 of IC3 will have a signal frequency of approximately 1 Hz, $(17190/2^{14})$. This output is connected to the latch input of IC1 via a monoflop (N6, R19, C10) and also to the reset input via inverter N7 and a second monoflop (N8, R20, C11). With the arrival of a negative going edge at Q14, a short pulse is fed to the latch input. A positive going edge at Q14 supplies the reset input with a pulse instead. The signal from Q14 is inverted by N7 and fed to 2 further monoflops; one (N3, R10, C5) driving the transmitter and another (N4, R11, C6) connected to the reset input of flip-flop FF1. The clock input of FF1 is connected to T7 and its $\overline{Q}$ output to N5. Therefore IC1 gets a reset pulse with every arrival of a positive going edge at the Q14 output of IC3, automatically zeroing the counter. At the same time the monoflop around N3 is activated (with a negative going edge at the output of N7), thus releasing a signal from the transmitter/oscillator for 0.3 ms. During this time period US1 transmits about 12 (40 Hz) pulses, which are then reflected by the subject, and received by US2. Simultaneously, the moment the ultrasonic signal is transmitted, FF1 is reset and held by monoflop N4 (almost 2 ms). Consequently output $\overline{Q}$ becomes logic '1' and the signal from the 17190 Hz oscillator is fed to the counter (IC1) via N5. Once the received and amplified sonic signal (burst) reaches the clock input of FF1, output $\overline{Q}$ becomes logic '0' with N5 blocking the counter input of IC1. The counter now contains the actual distance measured in cms. N6 activates the latch moving the contents of the counter into the latch, which is then displayed. The counter is reset by the next positive going edge at Q14 allowing a new measurement to be taken. The previous readout remains on display until the information from a new measured distance arrives. New readings can be taken every second.

There are some further aspects of the circuit which need a further explanation. US2 will of course pick up the transmitted signal immediately, unless we do something about it. If we do not avoid this the counter will be cut-off straight away defeating the whole exercise. We get over this problem by ensuring that the mono-time of N4 is considerably longer than the time it takes to transmit the 'burst' (2 ms). During this time frame the flipflop remains in the reset position, not caring whether a signal is present at the clock input or not. After the 2 ms FF1 is released so that the circuit does not confuse a reflected signal with a direct one. The only drawback of this inbuilt delay is that distances less than 35 cms cannot be measured, so you will have to rely on a ruler.

The circuit does not include an AGC in the receiver stage or an automatic error compensator (comparing a number of consecutive readings for the same distance), in order to keep it as simple as possible.

Constructional points to consider

The counter and display stages can be mounted onto one of our ready made printed circuit boards, as listed in the EPS lists as number 81105-1, (first issued in February 1981). Remember that Dp1, T1, C2a and C2b illustrated on the component overlay of this board are omitted. One side of R8 is fed to the decimal point (Dp2) the other to ground. Pin 6 of IC1 must also be connected to ground.

We suggest using veroboard for the rest of the circuit. Keep wiring as short as possible and the transmitting/receiving stages separated from each other. The two transducers are mounted side by side, (not touching) both facing exactly the same direction. We advise the use of flat 4.5 V batteries as a mains supply may cause stability problems. Power consumption is rather high at 250 mA, but this cannot be avoided when using a LED display. The use of an LCD was discounted as being too expensive for just an experimental circuit. Even so, the batteries should still have a long life simply because the circuit would normally be used a few seconds at a time.

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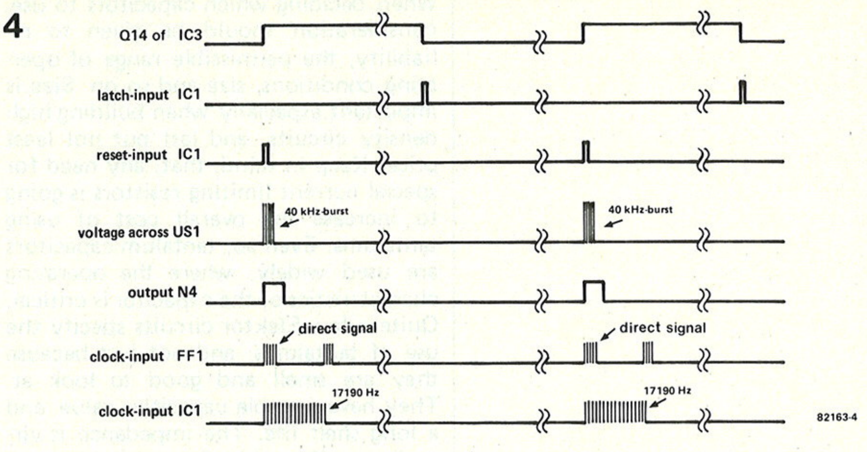

Figure 4. This figure denotes the different pulses and frequencies present at various points in the circuit.

The correct operation of several components and stages can be checked without the need for a scope. Interrupt the connection between N5 and the clock input and connect the latter to pin 4 of IC3 (output Q8). The display should then read 128. When the clock input is shorted to ground the display should read 000. This is a good way to check both the display and oscillator stage around IC3. The transmitting function can be checked quite easily, just by listening to US1. Although the actual 40 Hz signal cannot be heard, the 'burst' will be heard as a soft click, (one every second). Should you happen to hear Radio 3, then something is certainly wrong. In that case write to us and tell us how you did it! Testing the receiver is not easy, but you can assume all is well when the d.c. voltage at the collectors of T5 and T6 is approximately 4.5 V.

Once all this is done then the complete circuit can be tested and calibrated.

Turn the wiper of P2 to maximum, and take a note of the reading. This is produced by the counter between the reset and latch pulses, which are always half a second apart. It is important to remember that this reading will always be displayed when the receiver does not pick up a reflected signal. Now aim the circuit at an object like a closet, which is one metre away and has a vertical area of at least one metre square. Slowly rotate P2 backwards, until a certain point is reached when the display reads approximately 1 metre. Should this not occur and the read out is in the range of 40 to 60, then the transducers will have to be placed further apart, and a higher value capacitor used for C6. Once a setting of P2 is arrived at, which corresponds to a reading of 1 metre, we can go on to the next stage, which is to set the 40 Hz frequency.

Keeping the circuit in the same position, rotate P2, clockwise until the display is blank. Now rotate P1, until a reading is once again displayed. This procedure is repeated until it is no longer possible to blank out the display by any further adjustment of P2. Reposition the circuit a measured distance of let us say 5 metres from the subject and reset P2 only until the correct reading is displayed.

Finally position the circuit an exact distance (3 metres) always from the same subject, and adjust P3 until the display indicates the correct reading, and that is it!

We obtained very good results with the prototype. The accuracy was ± 2 cm at a maximum distance of 7 . . . 8 metres. The accuracy is dependant on the ambient temperature, air pressure and humidity, as these factors, influence the speed of sound. The range of the instrument can be extended by increasing the gain of the receiver and by increasing the transmitting voltage. Equiping the meter with an offset adjustment (to correspond to the length of the meter housing), will allow wall to wall measurements.

This particular design can also be used in a car, so that the driver is always aware of the distance between himself and a wall or other vehicle. Very useful when trying to park! In fact this idea has already been put into practice by certain manufacturers. Any reader wishing to do this can modify the circuit quite easily by substituting the display for an acoustic indication. A series of rapid bleeps, which increase in number as the distance decreases, until a continuous tone is heard, advising an immediate halt, (unless you want to pay the repair bill that is).

electrolytics run dry

everything you wished to know!

So far for many industrial and professional applications wet electrolytics and tantalums have ruled the roost. With new innovations and technological advancements, it is now possible to use alternatives which can be cheaper and more reliable. Many factors need consideration when making the right choice, and a good knowledge of the merits and limitations of the different types available is useful.

In fact a comparison shows that the new solid aluminium electrolytics, can be used as alternatives for tantalums, and in many respects can be seen to be better.

When deciding which capacitors to use, consideration should be given to reliability, the permissible range of operating conditions, size and so on. Size is important especially when building high density circuits, and last but not least price. Keep in mind, that, any need for special current limiting resistors is going to increase the overall cost of using tantalums. Even so, tantalum capacitors are used widely, where the operating characteristics of the capacitor is critical. Quite a few Elektor circuits specify the use of tantalums, and not just because they are small and good to look at. They have a stable capacitive value, and a long shelf life. The impedance is virtually unaffected by frequency changes. So, on the face of it tantalums are ideal. However, they do have one major drawback; price!

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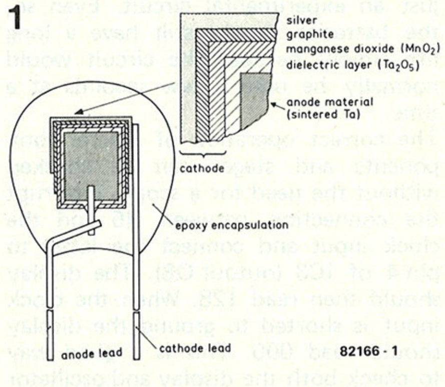
silver
graphite
manganese dioxide (MnO$_2$)
dielectric layer (Ta$_2$O$_5$)
anode material (sintered Ta)
cathode
epoxy encapsulation
anode lead
cathode lead
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Figure 1. Diagram of the structure of tantalum electrolytic.

With such an incentive as this, some type of alternative was needed.

With the constant improvement in technology, coupled with energy saving and the conservation of natural resources, many experts started to question the sanity of using tantalum for capacitors. Tantalum is now in limited supply, as with everything else, and its price is increasing by leaps and bounds. So, why use tantalums?

We must first of all keep in mind that at the time that they emerged onto the market, the only other type, with which they could be compared, were the wet aluminium electrolytics. These were and still are inexpensive, but are generally larger than any solid counterpart and suffered from a relatively short shelf life. By this we mean, that after long storage, their leakage current increases, and can only be restored to its original value by post-forming. Also, if they are used close to their maximum operating temperature, their life expectancy, which is normally far less than solid types, is curtailed even more. The wet type could not be used in certain new applications, and certainly fell down, for high frequency designs.

From the offset for many applications the tantalums did not have too much competition, and with the craze for miniaturisation they filled a need straight away. The biggest factor initially in favour of tantalums was this question of shelf life. Even after years of storage, their current leakage, and value remain unchanged. In fact their shelf stability is about 100 times better than the wet aluminium type.

Apart from everything so far explained the tantalums were not embarrassed by temperature. The wet electrolytics are affected quite considerably by temperature, causing large increases in the leakage current level. It is this failure to dissipate heat that causes their mediocre conductance.

By comparison the tantalums have a wide operating range as far as temperature is concerned, making them suitable for filters and oscillators. Hence the reason why they are widely used in Elektor designs.

Most of you by now must probably think that the writer must be completely sold on tantalums. Not so! They do have, what can be termed as inconveniences, rather than faults or disadvantages:

- The voltage level they can sustain when connected the wrong way round is extremely small, even for a very short interval. They breakdown rapidly and can explode easily.
- Their a.c. voltage performance is poor and further diminished at high frequencies and temperatures.
- The charge/discharge rate resistance is 3 Ω/V, making it necessary to use series resistors.
- A surcharge, whether it is of a thermo, current, or voltage nature, will cause immediate breakdown, short circuiting and a possible explosion.
- The price of each item is quickly approaching prohibitive levels.

All in all tantalums are certainly not perfect, mind you what is these days! Should series resistors not be used in order to limit the charge/discharge rate, then the results are always fatal. This is because field crystallisation will occur, causing short circuiting.

At the beginning of the article we explained all the advantages of using tantalums; impedance, heat dissipation, life span, high frequency performance and so on. But, it seems that it did not take us very long to arrive at the conclusion that even these are not as good as we would wish. As with many things, it is a fact of life that the more you use something the less appealing it becomes. Notice that we do not say everything, since the good things in life are always welcome.

Luckily the capacitor manufacturers have not stood still and have come up with a relatively new development. Using deeply-etched foil an axial-lead solid aluminium electrolytic has been created, achieving a high CV density making them less expensive replacements for tantalums. Although they are not going to depose the latter completely, they will be very widely used in a variety of industrial and professional equipment.

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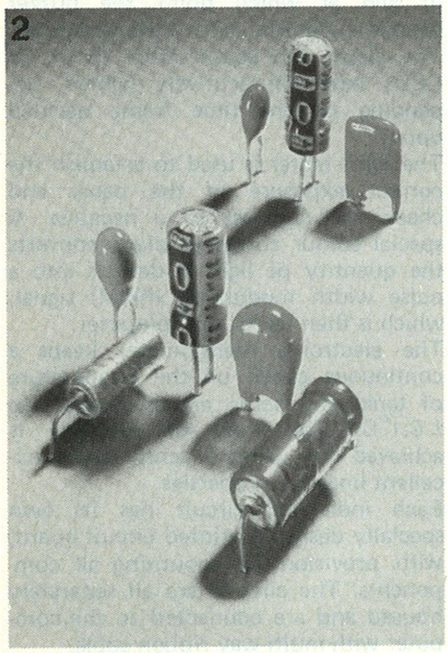

Figure 5. Stability of the main electrical parameters of the three types of electrolytic as a function of time. The curves are for a 0.1 μF item measure at 85°C.

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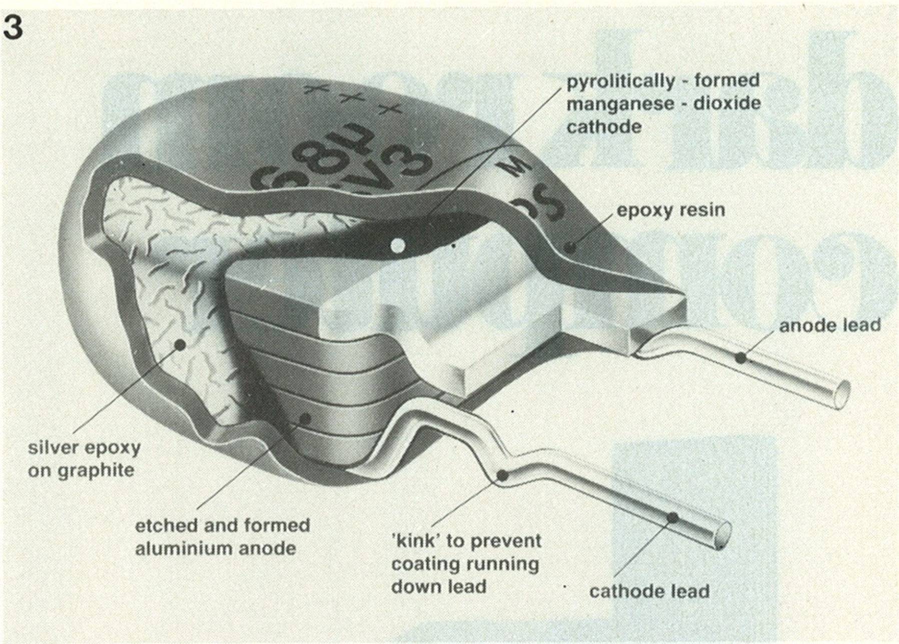

Figure 3. Structure of a solid aluminium electrolytic.

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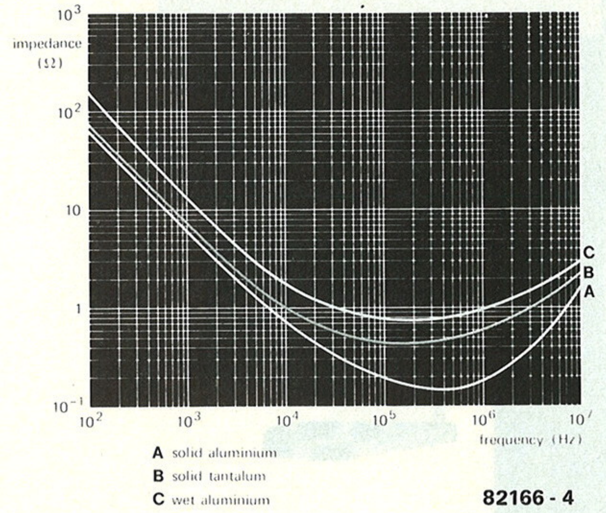


Figure 4. Impedance as a function of frequency with capacitor type as a parameter. All capacitors are 33 μF, 10 V.

Solid aluminium capacitors

The solid aluminium electrolytic has a comparable performance with the tantalum type, but not only is it cheaper, but it does have a few advantages. Figure 1 shows the different components which go to make a tantalum. There are a lot of similarities in construction with the solid aluminium type (SAL). Looking at figure 1, you will note that the former has layers of silver, graphite and manganese dioxide (MNO_2) which form the cathode. Then comes a dielectric layer and finally the anode made of tantalum. This is sintered to the tantalum oxide (dielectric layer).

Figure 3 shows the make up of a SAL. The cathode is composed of the same materials as the tantalum. The real difference between the two lies in the fact that, the anode is composed of deeply etched aluminium and that the dielectric layer is aluminium oxide AL_2O_3. Hence the remarkable conductivity of the solid aluminium electrolytic!

These SALs, to coin a phrase, are very robust to say the least. They can operate near their maximum temperature ratings without shortening their life span, and do not have any catastrophic failure mechanism. In other words they are not going to blow-up in your face at the wrong moment. An added bonus is the fact that series resistors are not needed.

The values already available are in the range 47 . . . 1000 μF and one major manufacturer has proposed to make smaller ones with 0.22 . . . 47 μF, but, it may take some time before these are available.

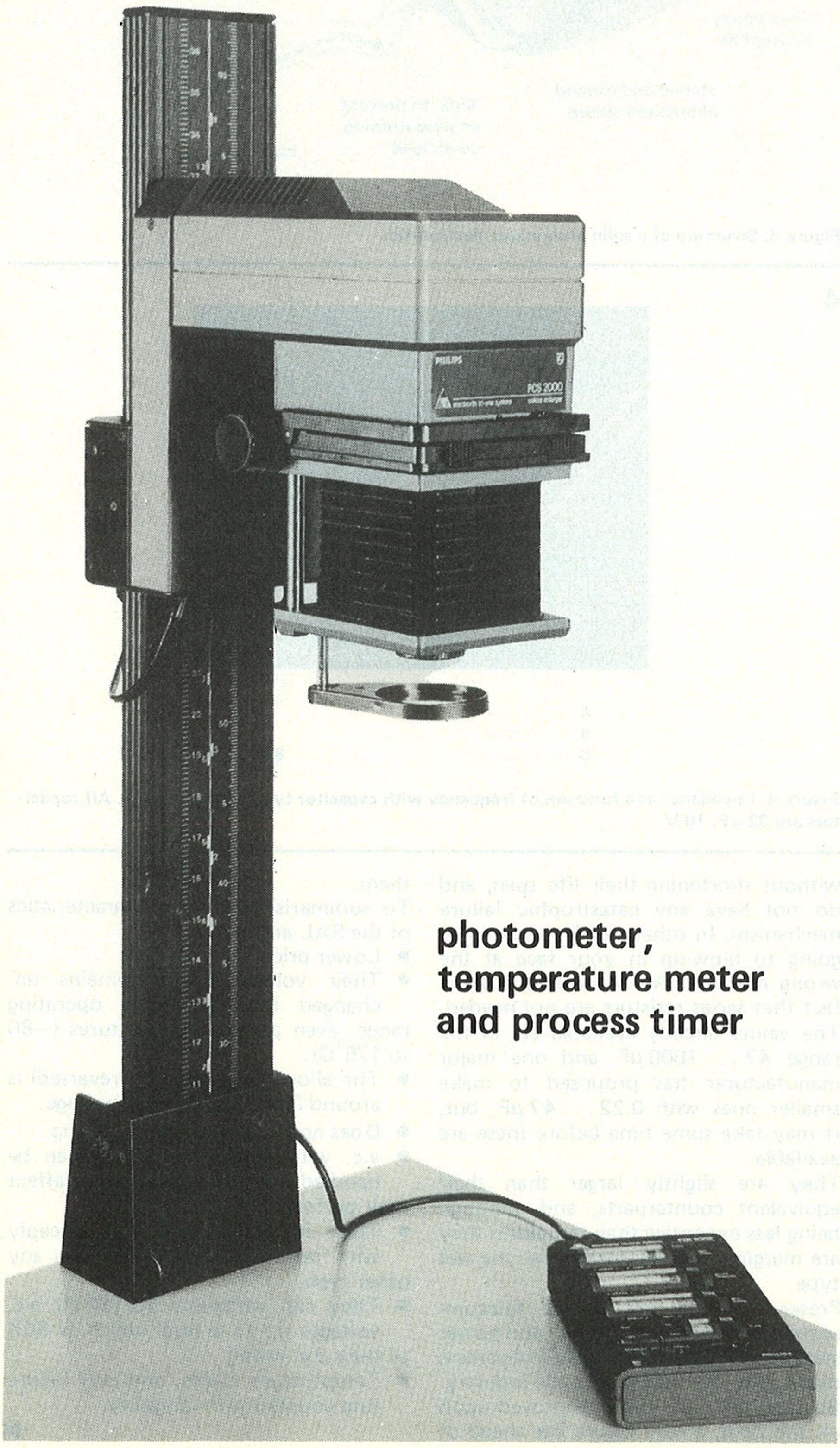
They are slightly larger than their equivalent counterparts, and although being less expensive than tantalums they are marginally more costly than the wet type.

Present applications include telecommunications, space programs, and power stations. Their small size and robustness make ideal for the automobile industry. Because they are being improved upon all the time, a rosy future lies ahead of them.

To summarise the main characteristics of the SAL are:

- Lower price.
- Their voltage rating remains unchanged throughout the operating range, even at high temperatures (−80 to 175°C).
- The allowed d.c. voltage (reversed) is around 33% of their rated voltage.
- Does not require current limiting.
- a.c. voltages (up to limits) can be handled and do not adversely affect their performance.
- Their impedance fall more steeply with increasing frequency than any other type.
- They can withstand 50/100 Hz a.c. voltages up to a level which is 80% of their d.c. rating.
- Temperature stable, and low failure rate coupled with longevity.

darkroom computer



photometer, temperature meter and process timer

Readers who have already read the 'instructions for use' in the previous issue, will have a pretty good idea of the capabilities of the darkroom computer. However, before all the available features can be used the necessary accessories have to be constructed. In this case there are three such circuits; to measure light, temperature and a time/sequence indicator.

The processor timer is little more than a box containing a series of LEDs in a line giving an optical indication of the passing of time. After all, it is nice to know how much longer a particular photograph has to remain in the development tank of bath, rather than panic at the last moment when the acoustic alarm is heard. The rows of LEDs, in effect, indicate the amount of time that has elapsed since the start button was pressed. How long each LED remains lit and at which point the buzzer sounds is determined by the computer. The alarm can sound after 15 or 25 LEDs have consecutively lighted, depending on the time frame decided upon.

The light meter is used to establish the correct exposure of the paper and check the contrast of a negative. A special colour corrected diode converts the quantity of light it detects into a pulse width modulated (PWM) signal, which is then fed to the computer.

The electronic thermometer keeps a continuous check on the temperature of tanks and baths, and is accurate to ± 0.1°C. This kind of accuracy is achieved by using a sensor with excellent linearity properties.

Each individual circuit has its own specially designed printed circuit board, with provision for mounting all components. The circuits are all separately housed and are connected to the computer with multi-way ribbon cable.

The process timer

The circuit of the process timer, as illustrated in figure 1, consists of 25 LEDs and two four-to-sixteen decoders. The address inputs of IC1 and IC2 are connected to lines PB0 . . . PB4, whereas, the LEDs are connected to outputs 1 . . . 15 of IC1 and 0 . . . 9 of IC2. The operation is straightforward. The binary code (which LED lights when) is fed to lines PB0 . . . PB4. PB4 is logic '0', enabling IC1, that is to say as long as the binary number is below 16. When the binary number is between 16 and 25, then PB4 will be logic '1' and IC2 will be enabled.

The LED display is multiplexed in the interests of the power supply. During 2.5 ms the first code for the first LED is put onto lines PB0 . . . PB4, and during the next 2.5 ms the code for the second and so on. If only one LED is 'running', during the second time period a '0' will be on lines PB0 . . .PB4, and as output o of IC1 is disconnected nothing will happen.

The set-reset flip-flop, constructed around N1 and N2, is on the left-hand side of the circuit diagram. This flip-flop really acts as a noise suppressor for switch S1, and is linked to the $\overline{\text{NMI}}$ connection of the processor. Depressing S1, the flip-flop supplies the $\overline{\text{NMI}}$ line with a negative going edge, which starts the process timer program and lights the first LED. Pressing S1 a second time starts a second LED 'running' at a time interval from the first, enabling two processes to be timed. If S1 is then depressed a third time, nothing will happen. Programming the timer is described in the constructions for use published in the previous article (part 1). The oscillator and piezo buzzer is activated when a logic '1' appears on line PB6. Potentiometer P1 adjusts the output volume of the buzzer.

One aspect of the total process timer is important. After having read both articles it becomes apparant that there are in fact two timers. One, let us call it the second one is included in the computer, whereas, the first (a separate one) forms part of the remote circuit. This first timer works completely independantly of the second and therefore the computer, which allows all the other facilities to be utilised without interruption; ligth and temperature measurements, the running of the second timer and so on.

The light meter

As can be seen by looking at the circuit diagram in figure 2, the light meter is the smallest accessory. However, it would be a mistake to assume that it is also the simplest. After all the differences in light levels to be measured in any darkroom are going to be very small indeed! It is therefore essential to have a good quality sensor such as the BPW 21. This particular photo diode has almost the same light and colour sensitivity as the human eye, which makes it also suitable for colour definition measurements. Further more its conversion of light to current is extremely good, as far as linearity is concerned (range of 10^{-2} . . . 10^{5} lux). A photo diode reacts very quickly to changing light conditions, in contrast to light dependant resistors (LDRs) which need a considerable amount of time to adjust especially in low levels of light.

The current flowing through the photo diode is proportional to the intensity of light. So that the processor can handle the information, the current has to be converted into some form of digital signal. The simplest solution was to use a current to PWM converter. A closer look at figure 2 may give the idea that the photo diode is short circuited, after all it is connected between the ground and the inverting input of IC1. This is correct, because this forms a virtual earth connection due to the feedback loop via IC1. This technique is used to ensure that the operation of

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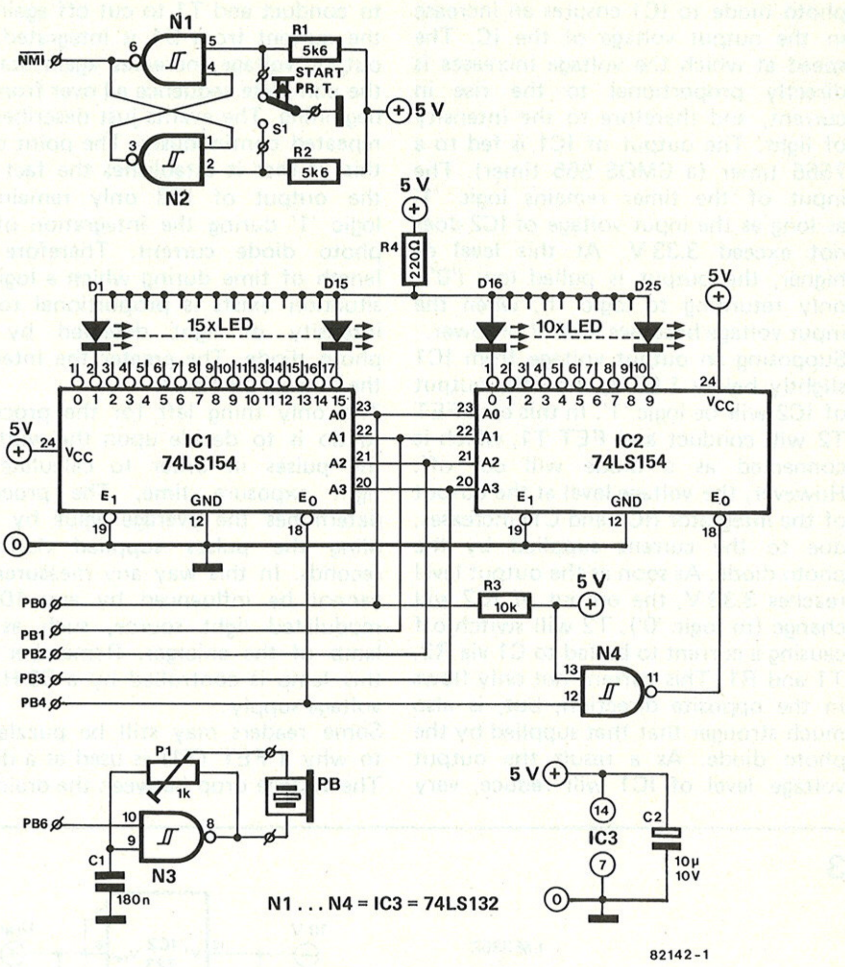

Figure 1. The circuit diagram for the process timer. The passage of time is displayed by means of 25 LEDs.

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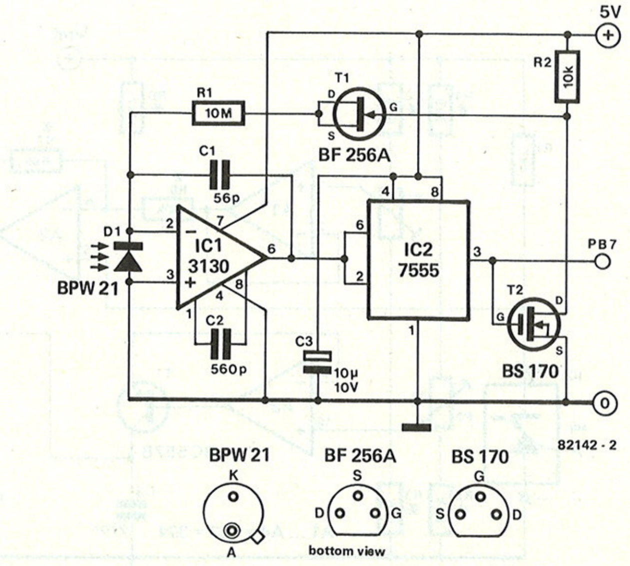

Figure 2. The circuit diagram of the light meter. The somewhat unconventional use of T1 is explained in the text.

the diode is independant (as much as possible) of ambient temperature changes. The current supplied by the photo diode to IC1 ensures an increase in the output voltage of the IC. The speed at which the voltage increases is directly proportional to the rise in current, and therefore to the intensity of light. The output of IC1 is fed to a 7555 timer (a CMOS 555 timer). The input of the timer remains logic '1' as long as the input voltage of IC2 does not exceed 3.33 V. At this level or higher, the output is pulled low ('0'), only returning to logic '1', when the input voltage becomes 1.66 V or lower.

Supposing an output voltage from IC1 slightly below 1.66 V, then the output of IC2 will be logic '1'. In this case FET T2 will conduct and FET T1, which is connected as a diode will cut off. However, the voltage level at the output of the integrator (IC1 and C1) increases, due to the current supplied by the photo diode. As soon as the output level reaches 3.33 V, the output of IC2 will change (to logic '0'), T2 will switch off causing a current to be fed to C1 via R2, T1 and R1. This current not only flows in the opposite direction, but, is also much stronger that that supplied by the photo diode. As a result the output voltage level of IC1 will reduce, very quickly. Consequently when the output of IC1 reaches 1.66 V, the output of IC2 will return to a logic '1', causing T2 to conduct and T1 to cut off again. As the current from D1 is integrated, the output voltage increases again starting the complete sequence all over from the beginning. The events just described are repeated continuously. The point of all this, is that it establishes the fact that the output of IC2 only remains as logic '1' during the integration of the photo diode current. Therefore the length of time during which a logic '1' situation exists is proportional to the intensity of light detected by the photo diode. The greater the intensity the shorter the time!

The only thing left for the processor to do is to decide upon the width of the pulses in order to calculate the right exposure time. The processor determines the average value by sampling the pulses supplied during 2 seconds. In this way any measurement cannot be influenced by any 100 Hz modulated light source, such as the lamp of the enlarger. Remember that this lamp is controlled by a 50 Hz a.c voltage supply.

Some readers may still be puzzled as to why a FET (T1) is used as a diode. The voltage drop between the drain and source of T2 is still a few millivolts when it is conducting. Therefore T1 prevents any current flow through R1, no matter how small. Should current flow via R1 any measurement will be cancelled out, since the current through the diode is still about 100 pA, with low levels of light. At low voltages, a FET connected in this way has a much lower voltage leakage than any normal diode. For example at 200 mV, a BF256A used in this way has a current leakage of 20 pA, whereas a 1N4148 would have about 12 nA! Quite a a difference!

With such low current levels a very low leakage integration capacitor is also necessary. A type which has a time constant of more than 100 s should be used for C1. In other words the internal leakage resistance multiplied by the capacitance must exceed 100 s. The input current of IC1 is typically 2 pA, with a supply voltage of 5 V, which means it does not need to be taken into consideration (negligible).

The thermometer

The electronic thermometer also works under the same principle of pulse widths. The sensor in this circuit is an LM 335, which is in effect a temperature sensitive zener diode. The voltage

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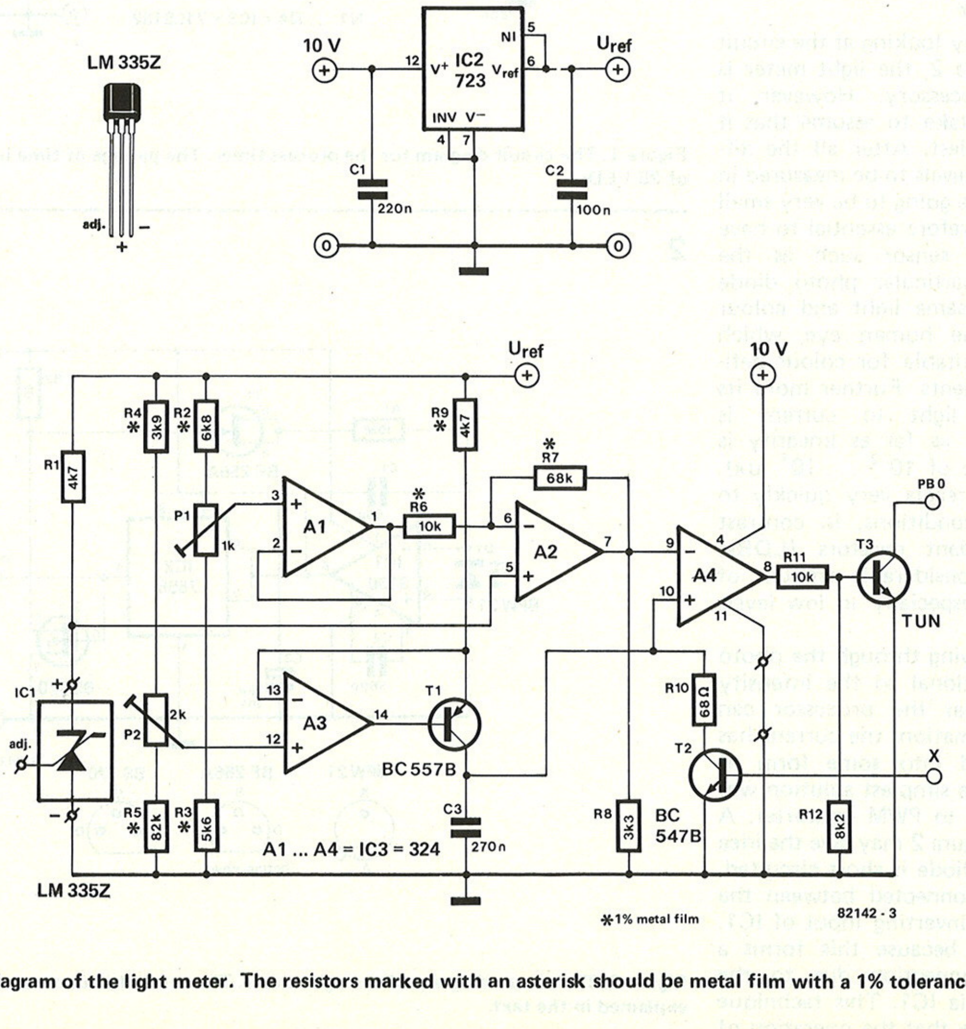

Figure 3. The circuit diagram of the light meter. The resistors marked with an asterisk should be metal film with a 1% tolerance to ensure accurate readings.

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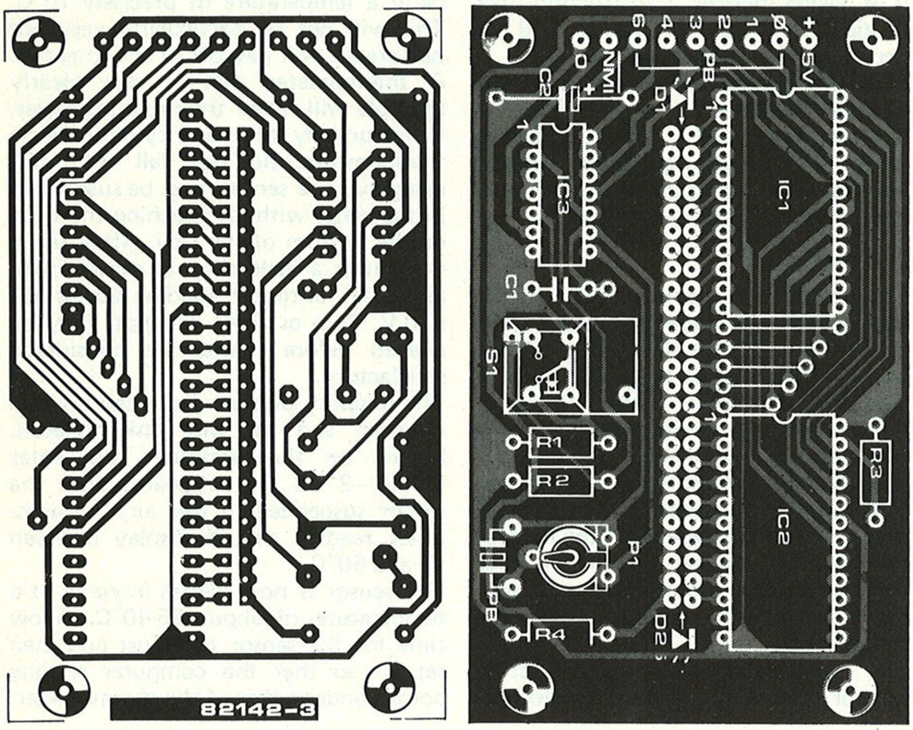

Figure 4. The printed circuit board for the process timer has been designed to fit the BOC 430 case from West Hyde.

Parts list for the process timer

Resistors:
R1,R2 = 5k6
R3 = 10 k
R4 = 220 Ω
P1 = 1 k preset

Capacitors:
C1 = 180 n
C2 = 10 µ/10 V

Semiconductors:
D1 . . . D25 = LED
IC1,IC2 = 74LS154
IC3 = 74LS132

Miscellaneous:
S1 = digitast switch
PB = piezo buzzer Toko PB 2720 (Ambit)

supplied by this diode in mV is equivalent to ten times the temperature in degrees kelvin, so that at 0°C (273 K) the diode voltage is 2.73 V. The sensor is accurate over the measuring range 15 to 50°C, which is ideal for use in darkrooms.

Figure 3 illustrates the circuit diagram of the temperature meter or thermometer. The voltage drop across the sensor is applied to the positive input of A2. Under normal conditions the gain of A2 is set to approximately 8 X. Opamp A1 supplies a reference voltage, determined by P1, to the inverted input of A2. Preset P1 is adjusted so that the output of A2 is 0 V at a temperature of 10°C, and 800 mV at 20°C. This output is then fed to the inverted input of a comparator A4. The other input of A4 is connected to a linearising capacitor C3. This capacitor is charged with a constant current source, fed via A3, T1, R4, R5, R9 and P2. When the voltage level across C3 exceeds that from the output of A2, the comparator A4 causes T3 to conduct. In effect, the time it takes for C3 to be fully charged is what we are interested in as this is proportional to the temperature.

Once T3 conducts, C3 discharges via T2, which you will notice is connected in parallel to C3. The base of T2 is in turn connected to the X terminal of the darkroom computer. The processor supplies, via this line, 10 pulses per second, during the measuring period. This pulse train causes T2 to conduct and C3 to discharge ten times a second. With a logic '0' on line X, T2 is not conducting and C3 charges. The time taken between a logic '0' on line X, and when '0' appears at the output of T3 on line PBØ, is used to determine the temperature. It is in effect this information that is digested and processed by the computer, which then shows it as a temperature reading on the display.

Construction

Process-Timer

Figure 4 shows the printed circuit board and component overlay for the process timer. This has been designed so that it can be mounted into a BOC 430 case from West Hyde. A slot is needed in the top of the case to accommodate the LEDs (25). Do not forget to make the necessary holes for the press-switches. For a graduated scale and indicator we suggest two strips of card fitted on either side of the LEDs. On the one side a series of numbers (for the LEDs), and process periods on the other. The photograph in figure 5, gives good idea as to how this proposal will look. For the prototype we used, the first block to denote the development, the second for the stop bath and the last for the fixer. In order to keep to this time frame, the alarm must be programmed to sound when the 10th, 13th, and 19th LED is on.

Temperature meter

Figure 6 illustrates the printed circuit board for the temperature meter, or, to give it its correct title, the digital thermometer. The sensor is remote from the circuit. Care should be taken to ensure that the LM 335 is wired correctly. Only the centre (+) and the negative pins are used. The ADJ connection is not required and can be cut off. The terminals and soldered joints of the sensor should be encapsulated in epoxy resin. This ensures against short circuits and increases the reliability factor, (see photograph in figure 7).

The printed circuit can be mounted into its own case, in the main computer housing, or even within the process timer! The choice is left to the constructor, but, we suggest the latter. In this case the amount of external wiring is greatly reduced, because points PBØ and 0 can be combined with connections +10 V, X, PBØ, NMI, +5 V and 0 of the process timer into one length of multi-way ribbon cable fed to the computer. Try and keep the cable as short as possible, although, anything up to 2 metres will not cause problems.

The light meter

This is again a completely separate section and is the last accessory we will deal with in this article. The printed circuit board as illustrated in figure 8, is assembled in a rather unconventional manner. The components are in fact mounted on the track side of the board while the other side completely covered in copper. This acts as the earth plane and the front face of the housing. Screening from outside interference is of paramount importance for the circuit

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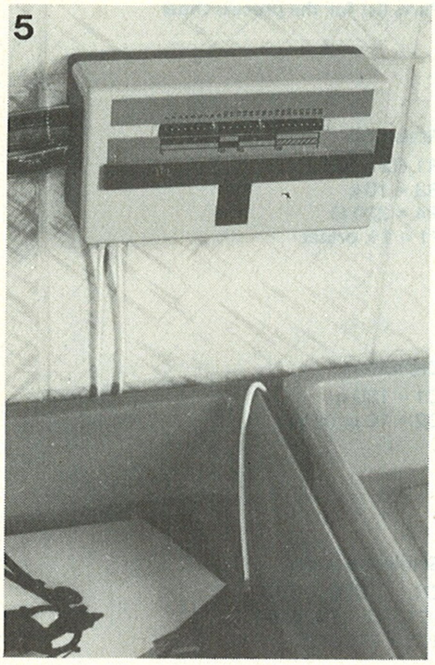

Figure 5. This photograph of the process timer illustrates one example of the timing card.

to operate correctly and, for this reason, the entire housing is constructed of copperclad board. The sides, ends and top and bottom of the case are simply soldered together. As the top (or front face) of the housing is the printed circuit board, this must be assembled before the rest of the case is fitted together. Care must be taken when mounting the components on the board as the risk of short circuits is high with this type of construction. However, the efforts are well worth while as the end result is very effectively screened and, incidentally, can also look very neat if care is taken.

Remember that, although the sensor is mounted inside the case on the same side of the board as the rest of the components, it must protude slightly through the board (sensor opening) enough to prevent it from being shielded. It can be fixed in place by the use of epoxy resin (or similar) but, be warned, an overzealous application of the 'sticky-stuff' can affect the sensitivity enough to prevent the circuit from operating at all. This was learned by experience on one of the prototypes.

It will be noticed that there is just one small hole through the printed circuit board. This may appear as though somebody started to drill all the holes through and then thought better of it! Not true of course. An off-cut of wire is fed through the hole and soldered both sides in order to earth the earth plane! Don't overlook this step or it will effectively nullify the whole exercise.

If the construction seems a little complex the illustration in figure 9 will clarify matters. The top and bottom of the case have the copper surface facing outwards while on the ends and sides it is facing inwards. Construction may be aided by the use of a vice to hold the parts together while soldering.

If your finished case is an excellent example of the art of air-tight boxes it is your own fault . . . the connecting wires to the microprocessor should have been fed through a hole in one end before completing the box!!

Calibration

The only circuit requiring calibration is that of the temperature meter. The link next to C3 on the printed circuit board of the temperature meter must first be removed. A power supply of between 3 and 10 volts (a 4.5 V battery if necessary) is connected to pin 11 of IC3 and earth (negative to pin 11). At this stage the temperature meter is connected to the computer but the latter is switched off. Firther requirements for the calibration procedure are a voltmeter, a thermometer and a developing tray of water.

The voltmeter is connected across resistor R8 and the sensor is placed in the tray of water. This is where the thermometer comes in. The water must be at a temperature of precisely 10°C. This will not be particularly easy but persistance will pay off in the long run. A thermometer that is very clearly readable will make the job a lot easier. Unfortunately, the majority of domestic thermometers do not fall into this category. The sensor must be suspended in the water without touching the sides or the bottom of the tray. After giving the sensor a little time to settle down, adjust P1 until the reading across R1 is 0 V. Two or three attempts may be needed before results are considered satisfactory.

The tempory power supply can now be removed and the wire link replaced. Switch on the computer and enter MEAS,–2 on the keyboard. With the sensor suspended in free air, the computer reading should display between 10 and 50°C.

The sensor is now placed in water at a temperature of about 35-40°C. Allow time for the sensor to adjust and then set P1 so that the computer reading corresponds to that of the thermometer.

Parts list for the temperature meter

Resistors:
R1 = 4k7
R2 = 6k8 1% metal film
R3 = 5k6 1% metal film
R4 = 3k9 1% metal film
R5 = 82 k 1% metal film
R6 = 10 k 1% metal film
R7 = 68 k 1% metal film
R8 = 3k3
R9 = 4k7 1% metal film
R10 = 68 Ω
R11 = 10 k
R12 = 8k2

P1 = 1 k multiturn preset
P2 = 2 k multiturn preset

Capacitors:
C1 = 220 n
C2 = 100 n
C3 = 270 n

Semiconductors:
T1 = BC 557B
T2 = BC 547B
T3 = TUN
IC1 = LM 335Z (National)
IC2 = 723
IC3 = 324

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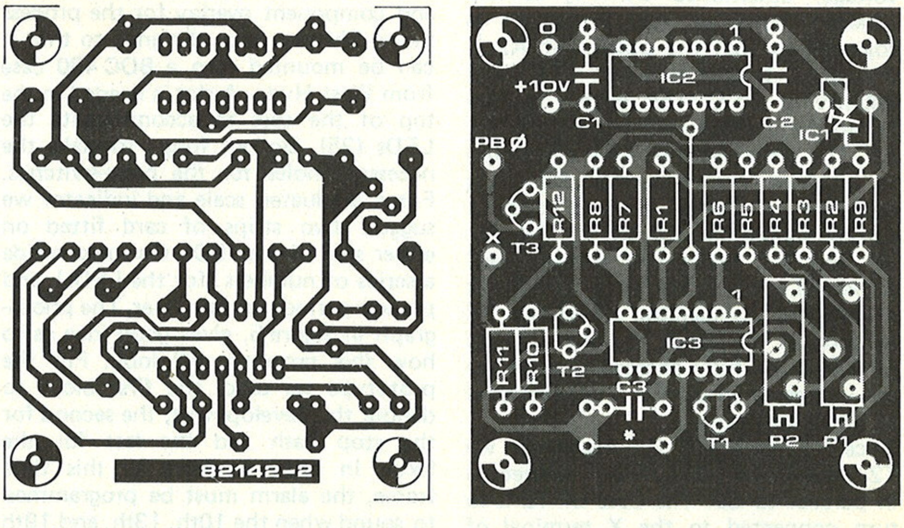

Figure 6. All the components for the temperature meter, with the exception of the sensor, are mounted on this printed circuit board.

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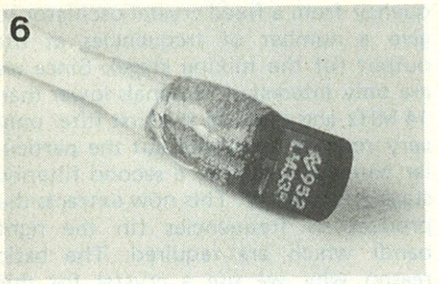

Figure 7. The two pins of the LM 335 sensor that are used should be encapsulated in epoxy resin as shown here.

Parts list for the light meter

Resistors:
R1 = 10 M
R2 = 10 k

Capacitors:
C1 = 56 p ceramic
C2 = 560 p
C3 = 10 μ/10 V

Semiconductors:
T1 = BF 256A
T2 = BS 170
D1 = BPW 21
IC1 = 3130
IC2 = 7555

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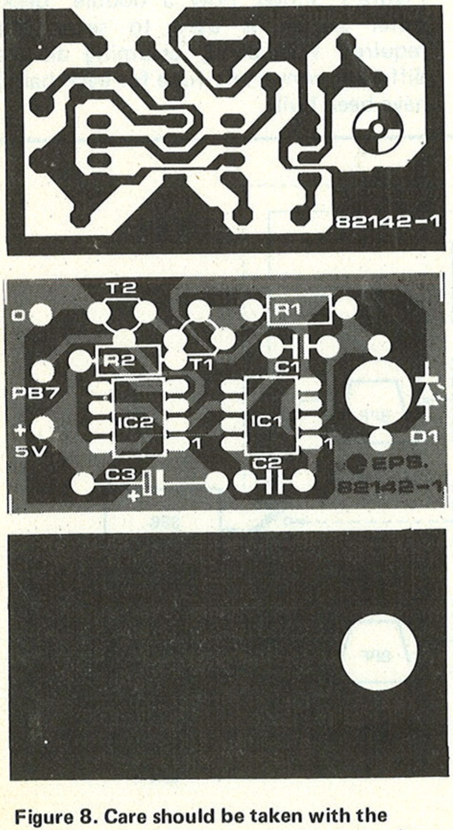

Figure 8. Care should be taken with the assembly of the light meter printed circuit board. As explained in the text, all the components are mounted on the same side as the track pattern.

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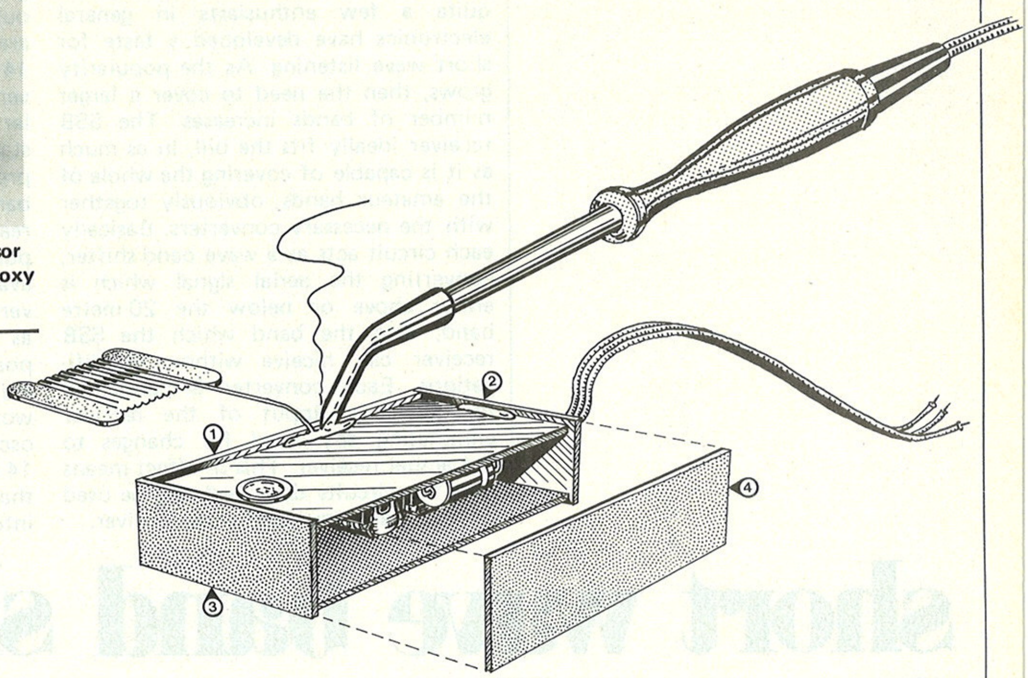

Figure 9. The construction of the light meter case is illustrated here. The printed circuit board forms the top face.

In practise . . .

Before dashing off to the darkroom and locking yourself in, it must be decided what times the different processes are going to take so that a process timer card can be drawn up. As an example we are going to use time factors associated with black and white photography. These can be 1.5 minutes for development, half a minute for the stop bath and one minute for the fixing bath. This is in fact the timing shown in the photograph in figure 5. Keeping in mind that the time from one LED to the next is 10 seconds, then the 'alarm' LEDs will be numbers 10, 13 and 19.

Pressing the START PR. T key will now begin the process time. However, it may be that a second timing procedure is required if, for example, a black and white film is to be developed. The timing for this can be 6 minutes for development, 1 minute for wash, 3 minutes for the fixing bath and then a 30 minute wash. In order to carry out this sequence the memory in the main computer will have to be programmed accordingly. Remember that up to 10 different time periods are available. The programming procedure for this has been covered in detail in the user instructions in part 1. Keep in mind the fact that it is also possible to program acoustic signals during the processing sequence. These will be a short bleep for each LED with a longer buzz for the end of each period.

A point in part 1 that may need further clarification is the multiplication factor relating to the light meter. Moving the sensor to different areas of the enlarged image will obviously change the light level falling on the sensor. If a number of positions are checked the computer can provide an average reading.

Another method that may be used requires a sheet of opaque tracing paper placed between the enlarger lens and the sensor. The image will of course be out of focus but a good idea of the average light level can be found in this manner. An 'average' negative must be used in order to arrive at a correction factor.

The paper in use is also an important factor when determining the exposure time. Therefore, by experience and the information of the materials used, an error adjustment (or multiplication factor) can be arrived at and entered into the computer which will then compensate accordingly. This factor need only be entered once as long as the same materials are used. This is really no different to any normal manual procedure only that, in this case, once the factor is found and entered into the computer it can be forgotten (after making a note of it!). The method of entering the multiplication factor into the computer was described in detail in part 1.

short wave band shifting for SSB receivers

from 14 MHz to 14 metres!

The article deals with and describes front ends which can be used with any short wave receiver, specifically the SSB described in our June issue, effectively extending the coverage of the amateur bands. One circuit is designed to convert the band below the 14 MHz 'up' into the required receiving range with the second converting down from higher frequencies again into the 14 MHz band. It is also possible to cover the 2 metre band using this technique. The circuits, as their name implies (front ends) can simply be connected to the input of the SSB receiver. The number of circuits required will only depend on the number of bands constructors wish to cover. Component values are given enabling up to 13 converters to be built, plus of course the original 20 metre band already in the SSB! This is a good way to increase your band coverage in nice easy stages.

Since we published the SSB receiver article in June of this year, it is apparent from all the letters received, that quite a few enthusiasts in general electronics have developed a taste for short wave listening. As the popularity grows, then the need to cover a larger number of bands increases. The SSB receiver ideally fits the bill, in as much as it is capable of covering the whole of the amateur bands, obviously together with the necessary converters. Basically each circuit acts as a wave band shifter, converting the aerial signal which is either above or below the 20 metre band, into the band which the SSB receiver can receive without modifications. Each converter is connected to the aerial input of the receiver eliminating any need for changes to the actual receiver. This in effect means that the circuits described can be used with virtually any short wave receiver.

Lower than 14 MHz

One of the simplest solutions for these wave lenths, is to use a band-pass filter, followed by a mixing stage which is in turn followed by another band-pass filter. The first filter is used to extract only the required wave band. This signal is then mixed together with the frequency from a fixed crystal oscillator to give a number of frequencies at the output (of the mixing stage). Since we are only interested in signals lower than 14 MHz and because the first filter only very roughly separated out the particular band in question, a second filtering stage is necessary. This now extracts the product of frequencies (in the right band) which are required. The basic reason why we use a crystal for this purpose is because they are easily available and relatively cheap. For the very low frequency bands (VLF), such as 10 . . . 140 kHz, which are also possible using this technique, things are slightly different. In this case we would use a crystal which gives an oscillator frequency slightly below the 14 MHz band, and then the result is that the summed up frequency comes into the desired band. In this case the first stage becomes a simple low-pass filter.

Figure 1 shows how a double 'deck' wafer switch is used to select the required wave-band, assuming all the different converters (one for each band) have been built.

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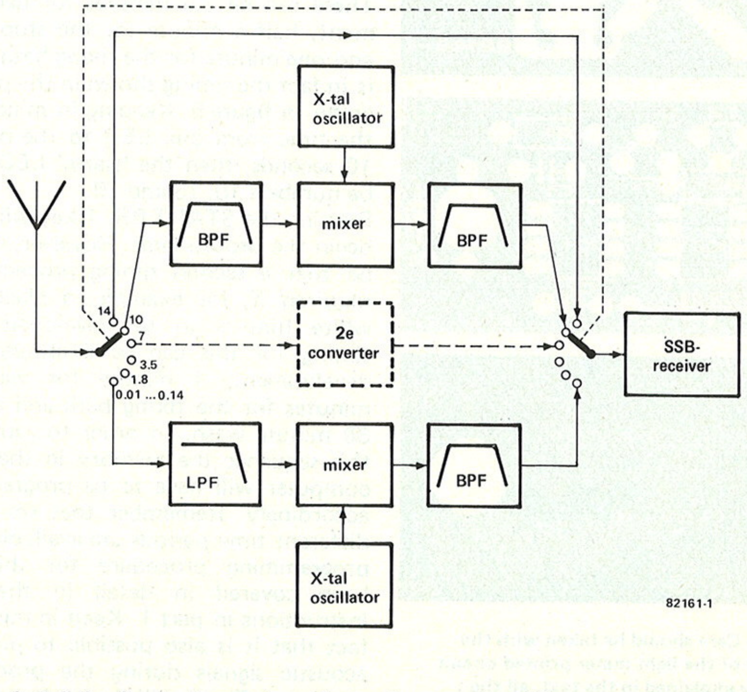

Figure 1. Building five 'up' converters, allowes the reception of five extra amateur wave bands (above 14 MHz).

Figure 2 shows the complete circuit diagram for a lower than 14 MHz converter as just described, which is in other words an 'up' converter. The part of the circuit in the bottom left hand corner which includes C1 . . . C6, L1 and L2 is the band-pass filter which caters for 1.8, 3.5, 7 and 10 MHz. Directly above this section is a stage consisting of C7 . . . C10, L3 . . . L5, which is the low-pass filter for the VLF. The component values needed for differing bands are shown in table 1. This is followed by the simple passive mixing stage constructed around the FET BF256C. This FET acts as a switch, which is controlled by the crystal oscillator built around T2. The sum and difference of the product of the filtered input frequency and the oscillator frequency, appears at the output of the mixer. The frequency from the crystal for the 1.8, 3.5, 7 and 10 MHz is chosen so that the difference of the product from the mixer falls into the 14 MHz band (which can be dealt with by the SSB receiver). For the very low frequency band 10 . . . 140 KHz, it is the sum of the frequencies which comes into the correct band. The value required for the crystal is for each case listed in table 1. The output of the mixer is then fed to a band-pass filter which ensures that only the 14 MHz band is brought to the input of the SSB receiver.

The input impedance of the converter with band-pass filter is 50 Ω and that of The VLF-one, 1 to 2 kΩ. The latter higher value ensures that a simple aerial (single piece of wire) will still provide adequate reception for that band. The loss in signal strength as a result of using a converter is 6 dBs, with a loss in the filter stage of 2 dB, which is very small.

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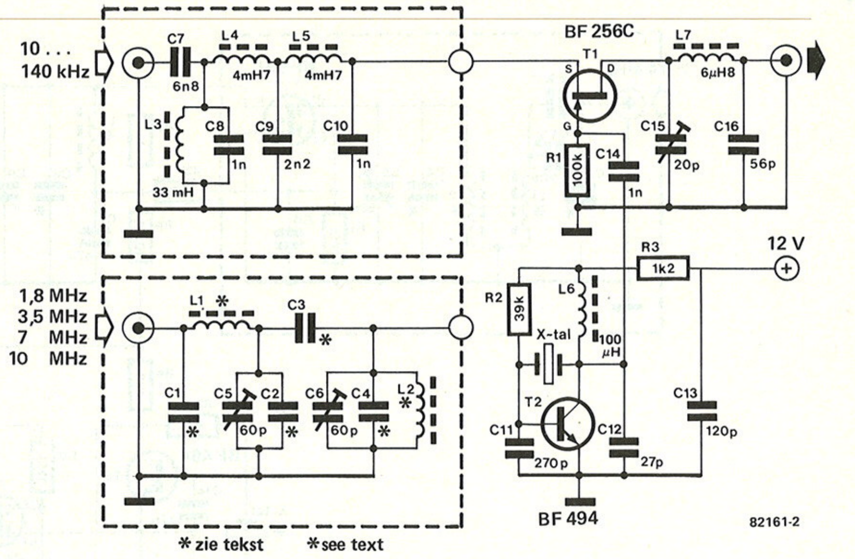

Figure 2. The converter for low frequencies. For VLF bands, a low-pass filter is mounted at the input (upper box insert). For all the other low bands the filter shown in the lower box section is used.

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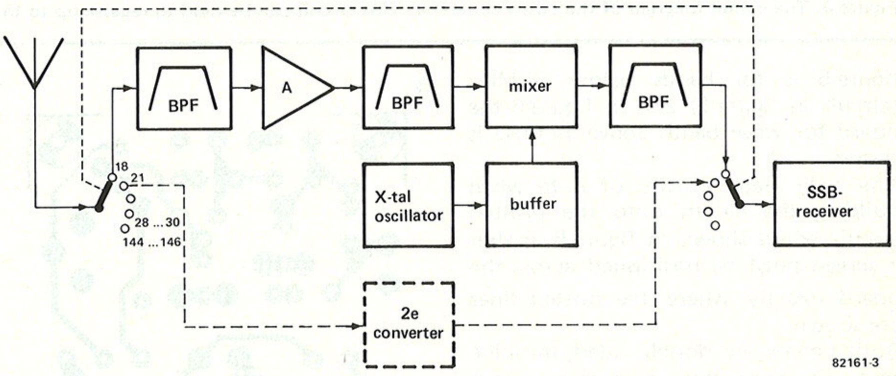

Figure 3. Block diagram for the down converter (above 14 MHz). Although this seems simpler than the circuit shown in figure 1, it does illustrate the principles used.
Again a separate converter is required for each band and a multi-way switch can be used to change the wave band.

Table 1. The component values for converters for lower than 14 MHz.

Band MHz	L1,L2 μH	C1 nF	C2,C4 pF	C3 pF	X kHz
0.01 . . . 0.14	—	—	—	—	14000
1.8 (160 m)	27	3.3	180	33	16200
3.5 (80 m)	8.2	3.3	180	15	18000
7 (40 m)	2.2	2.2	180	10	21300
10 (10 m)	1	1.5	150	6.8	24300

Higher than 14 MHz

The converters for anything higher than 14 MHz can be used right up to the 2 metre band! Figure 2 once again shows the circuit in block diagram form. The input stage is the same as before; a band-pass filter. But, then instead of going straight to a mixing stage an amplifier is included. From then on the sequence is identical, that is, as far as the block diagram is concerned. When the circuit itself is described in greater detail you will see that this is not the case. Again a crystal oscillator is used, but, in this case a further buffer stage has been included. The circuit diagram is shown in figure 4. The component values for the band-pass stage depend on the wave band required, and are shown in table 2. After the filter there is the amplifier T1 which is followed by a further filter set up in the same manner as the first (L3, C8, C9). A mixer follows this, with T2 being controlled by a crystal oscillator. Finally there is a buffer stage with T4. For all the wave bands listed in Table 2 the values have been calculated on the basis of the difference between the oscillator and the aerial input frequencies. After the buffer stage comes the last band-pass filter, ensuring only signals within the 14 MHz band are fed to the receiver.

At the foot of table 2 there is a separate box giving the component values needed for the 2 metre band. In this case a 65 MHz crystal is used, and the buffer stage also operates as a frequency doubler.

In the 2 metre version the gain of the converter is between 6 and 12 dB, and in the others approximately 4 dBs. In the latter versions the gain can be boosted by increasing the value of R3, but, then the value of L3 has to be lowered and C8 also increased.

Construction

Figures 5 and 6 show the printed circuit boards for all converters. The board in

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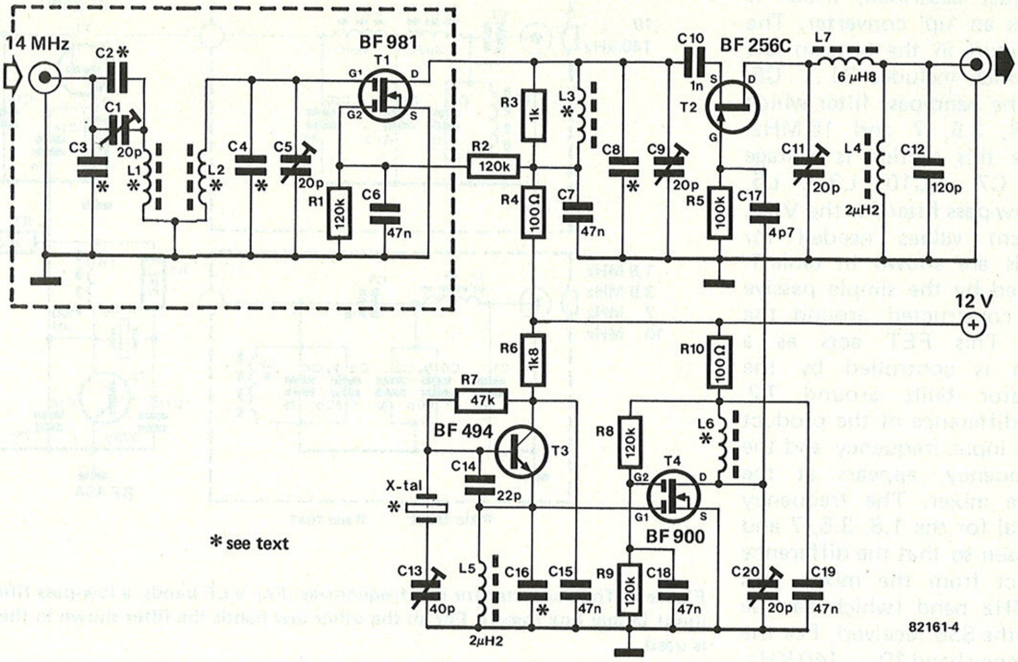

Figure 4. The circuit diagram of the down converter. This circuit can be used to receive up to the 2 metre band (144-146 MHz).

figure 5 is for bands below 14 MHz (circuit in figure 2) and in figure 6 the board for wave bands above 14 MHz is shown.

The only item worthy of note when building the circuit onto the printed circuit board shown in figure 5, is that a screen must be positioned across the board exactly where the dotted lines are shown.

Both boards are double sided, meaning that the component side is a copper plane which must be earthed.

The only really difficult circuit to build is the 2 metre version in as much as, the coils (L1, L2, L3) have to be wound by hand. L3 is the simplest coil to make, as it has only one turn, but L2 and L3 both have 4 windings each, so please take care. These coils must also be inductively coupled, which means they have to be mounted side by side and end to end, and not at right angles, (as shown on the layout). There is plenty of room allowing all this as some of the components, namely C2 and C4, are not needed for the 2 metre version. Figure 7 gives a clear illustration of this. A screen is also required on this board, to separate the input stage from the rest. The dotted lines as shown in figure 6 indicate where this is positioned. We suggest that all, the completed circuits are mounted into screened boxes. Although this involves a considerable amount of work the final results fully justify it.

Alignment

High frequency designs (RF) need great care when aligning. However, the

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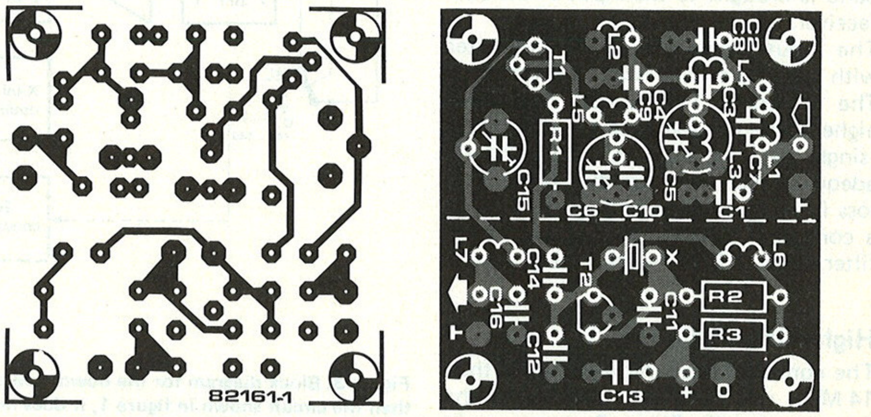

Figure 5. Printed circuit board for the lower frequency converter. The component side is a copper plane.

Parts list for below 14 MHz

Resistors:
R1 = 100 k
R2 = 39 k
R3 = 1k2

Capacitors:
C1,C2,C3,C4 = see table 1
C5,C6 = 60 p trimmer
C7 = 6n8
C8,C10 = 1 n
C9 = 2n2
C11 = 270 p
C12 = 27 p
C13 = 120 n
C14 = 1 n ceramic
C15 = 20 p trimmer
C16 = 56 p

Coils:
L1,L2 = see table 1
L3 = 33 mH
L4,L5 = 4,7 mH
L6 = 100 μH
L7 = 6,8 μH

Semiconductors:
T1 = BF 256C
T2 = BF 494

Miscellaneous:
X = crystal (see table 1)

6

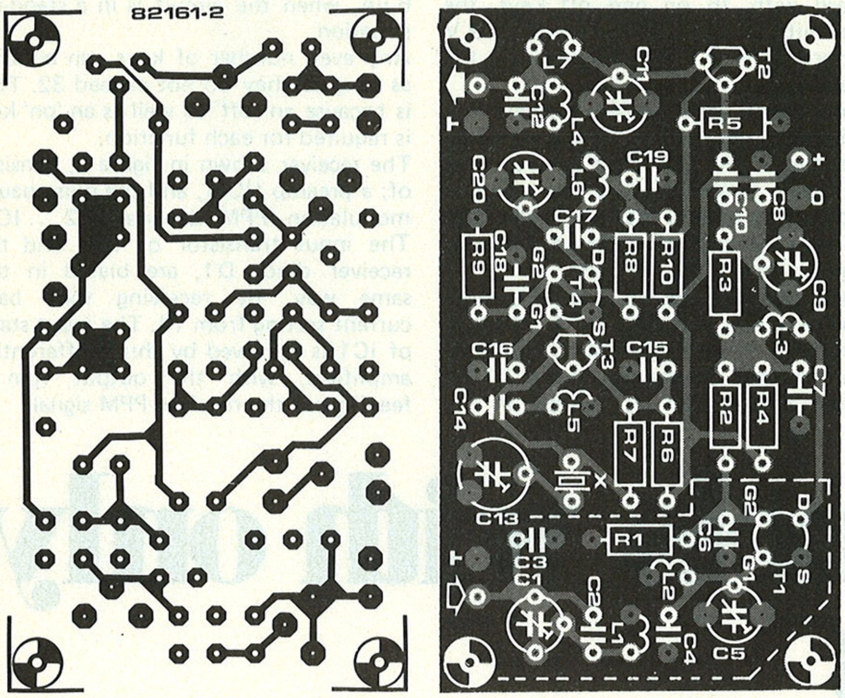

Figure 6. The printed circuit board for the down converter.

Table 2. The component values for converter for above 14 MHz.

Band MHz	L1,L2,L3 μH	X kHz	C2 pF	C3 pF	C4,C8 pF	C16 pF	L6 μH
18.068 . . . 18.168	2.2	32200	33	150	22	27	3.3
21.0 . . . 21.450	1.5	35450	33	150	22	22	3.3
24.89 . . . 24.99	1.5	39000	27	150	18	18	3.3
28.0 . . . 28.5	1	42500	15	68	10	12	2.2
28.5 . . . 29.0	1	43000	15	68	10	12	2.2
29.0 . . . 29.5	1	43500	15	68	10	12	2.2
29.5 . . . 29.7	1	44000	15	68	10	12	2.2

Components for the 2 m-band

L1,L2 *	L3 *	X kHz	C2,C4,C8	C3 pF	C16 pF	L6 μH	L7 μH	R3
4 wnd	1 wnd	65 000	delete	33	3.3	0.22	1.5	delete

* 0.6 mm enamelled copper wire, 8 mm ϕ, see text

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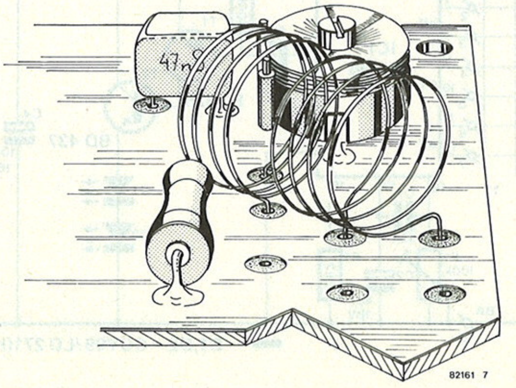

Figure 7. In the 2 metre version the coils L1 and L2 must be wound by hand and are inductively coupled.

Parts list for above 14 MHz

Resistors:
R1,R2,R8,R9 = 120 k
R3 = 1 k
R4,R10 = 100 Ω
R5 = 100 k
R6 = 1k8
R7 = 47 k

Capacitors:
C1,C5,C9 = 20 p trimmer
C2,C3,C4,C8,C16 = see table 2
C6,C15,C19 = 47 n ceramic
C7,C18 = 47 n
C10 = 1 n ceramic
C11 = 20 p trimmer
C12 = 120 p
C13 = 40 p trimmer
C14 = 22 p
C17 = 4p7
C20 = 20 p trimmer (see text)

Coils:
L1,L2,L3,L6 = see table 2
L4,L5 = 2,2 μH
L7 = 6,8 μH

Semiconductors:
T1 = BF 981
T2 = BF 256C
T3 = BF 494
T4 = BF 900

Miscellaneous:
X = crystal see table 2

alignment of the circuits so far described is not critical and is certainly straightforward. It is just a matter of adjusting all the trimmers until the maximum signal-to-noise ratio is achieved. Obviously as with any normal aligning procedure, every time one trimmer is set, it will influence the other, therefore each should be adjusted in turn (several times) until the correct alignment is achieved.

One final comment concerns the trimmer C13 in circuits catering for frequencies above 14 MHz (figure 4). This is used to ensure that the oscillator frequency is exactly what is required, getting rid of any discrepances in the crystal frequency. ◼

16 channels with only five ICs

There have been many circuits published for infra-red remote control systems of varying complexity. The design here however, while still providing 16 channels, keeps construction fairly simple by utilising special ICs produced for the purpose by Plessey. In fact, the circuit is similar to that found in many domestic television sets.

Control is by means of push buttons, and both the transmitter and receiver can be made very compact.

Figure 1 illustrates the circuit diagram of the transmitter. It contains; a keyboard with 16 on and off keys, the transmitting IC, and final stage. A 9 V battery such as the PP3 is ideal for the supply.

A command given by depressing a key is immediately converted into a corresponding E-D-C-B-A 5-bit binary code. We have purposely left the detailed explanation of how the code is allocated till later, as any reference to it as this stage could confuse the issue.

The 5 bit code, which is nothing more than a pulse sequence of 6 identical signals, is transmitted by modulating the infra-red diodes D1 and D2. The actual information, is hidden in the gaps, or breaks between pulses. A short pause denotes logic '1', a long one a logic '0'. Pulse and pause duration can be set with the aid of trimming potentiometer P1. Keep in mind that a logic '0' pause is about 1.5 times longer than a logic '1', and that each pulse is approximately 3 ms. There is preset delay period of 54 ms between any two different commands. Infra-red radiation is only possible when pin 3 of IC1 is pulled low. This is the only way that a current 'pulse' or surge (lasting about 15 µs), will flow through T2 and the diodes. As a matter of interest this can be as high as 8A!

The IC contains an internal electronic operational switch, ensuring that the power consumption does not exceed 6 µA, when the circuit is in a stand-by situation.

Any even number of keys can be used as long as they do not exceed 32. This is because an 'off' as well as an 'on' key is required for each function.

The receiver shown in figure 2, consists of; a preamp (IC1), and the pulse pause modulation (PPM) decoder, IC2 . . . IC4. The input transistor of IC1, and the receiver diode D1, are biased in the same way, by receiving their base current setting from T1. The input stage of IC1 is followed by three differential amplifiers, with the output (pin 2) feeding out the received PPM signal.

PPM decoder

ICs ML 928 and 929 can be found in various kinds of circuits, although they were originally designed for use in TV sets. They each contain; a PPM demodulator, time base generator (together with an oscillator), and a shifting register with following latches/memories. The binary information is in fact, located at the output of the latches. Apart from all this, there is an integrated comparator taking care of the error correction, automatically! So, under normal conditions nothing can go wrong, what so ever! Each IC is able to digest and process 16 commands converting the received information into

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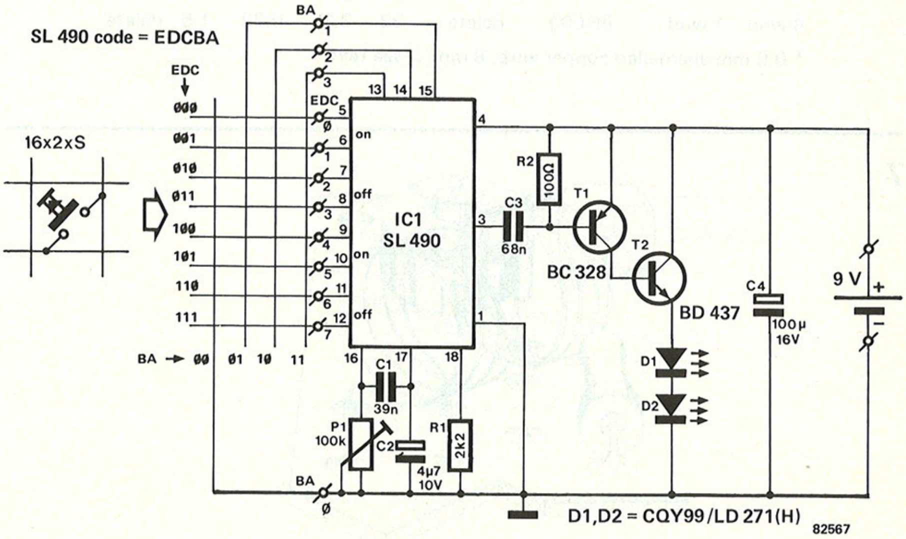

Figure 1.
The transmitter consists of; a keyboard, transmitter IC, final stage and a 9 V battery.

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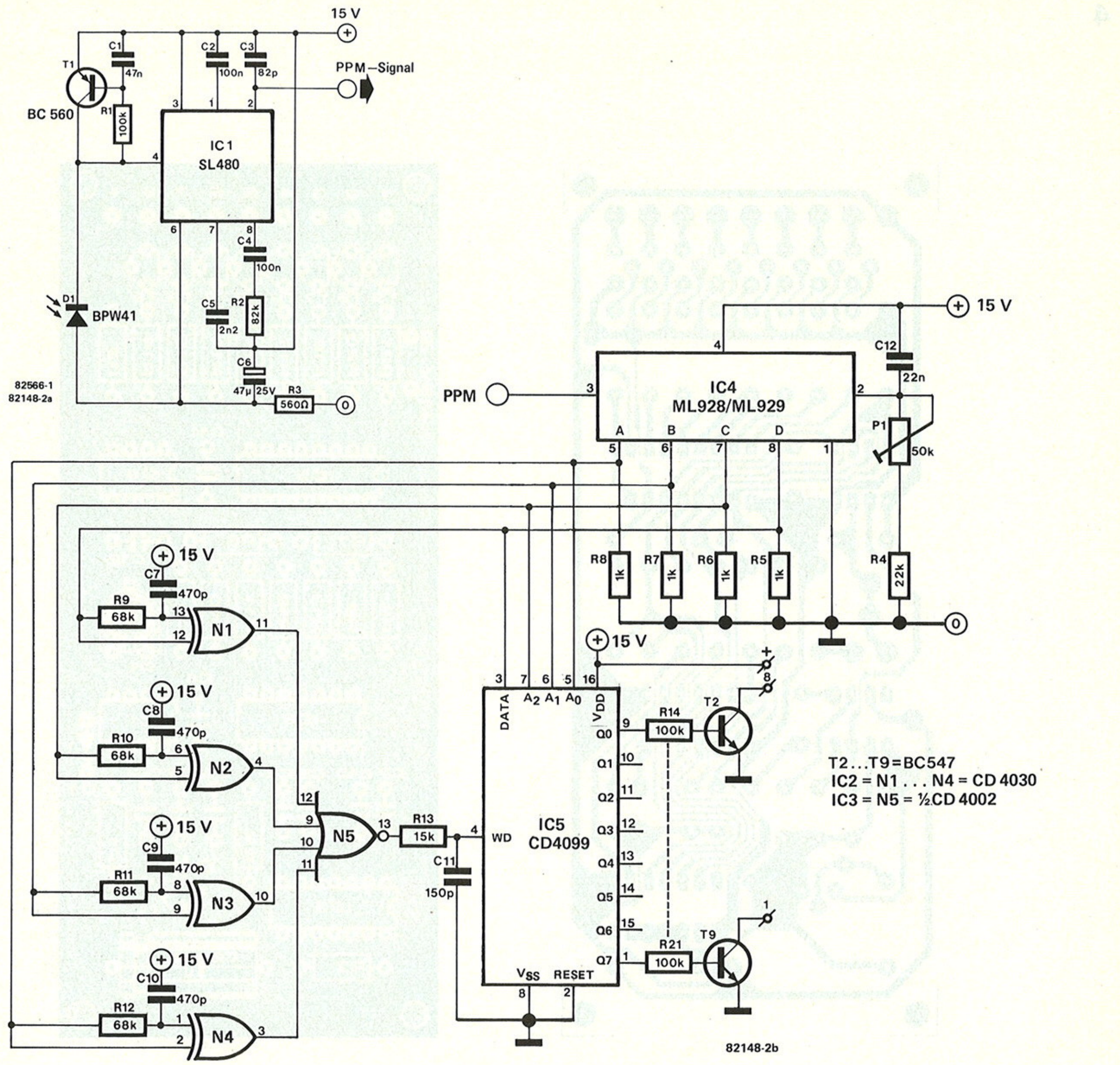

Figure 2.
The receiver consisting of; a pre-amp with IC, PPM decoder (IC2 . . . IC4).

Parts list figure 3

Resistors:
R1 = 2k2
R2 = 100 Ω
P1 = 100 k trimmer

Capacitors:
C1 = 39 n
C2 = 4µ7/10 V
C3 = 68 n
C4 = 100 µ/16 V

Semiconductors:
D1,D2 = CQY 99 or LD 271(H)
T1 = BC 328
T2 = BD 437
IC1 = SL 490 (Plessey)

Miscellaneous:
Reflector for D1/D2
9 V battery

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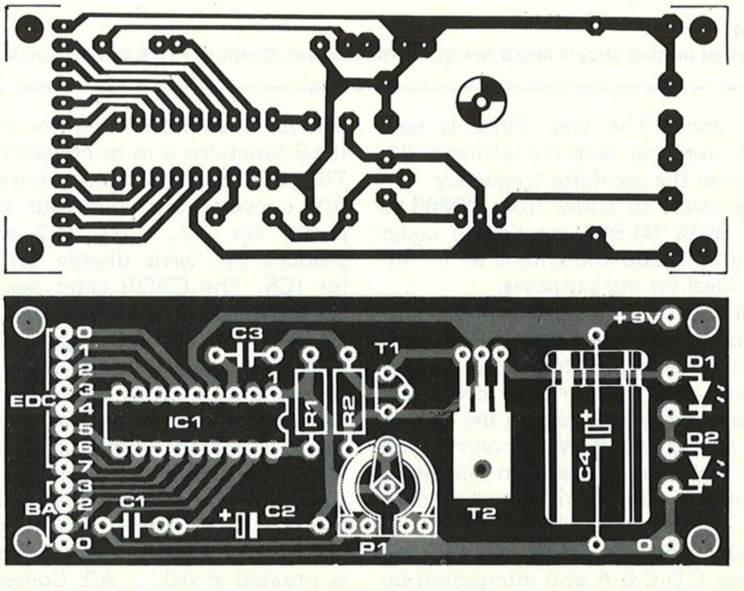

Figure 3.
A suggested track pattern and component overlay design for the printed circuit board of the transmitter. The LEDs are equipped with a reflector for a stronger light beam.

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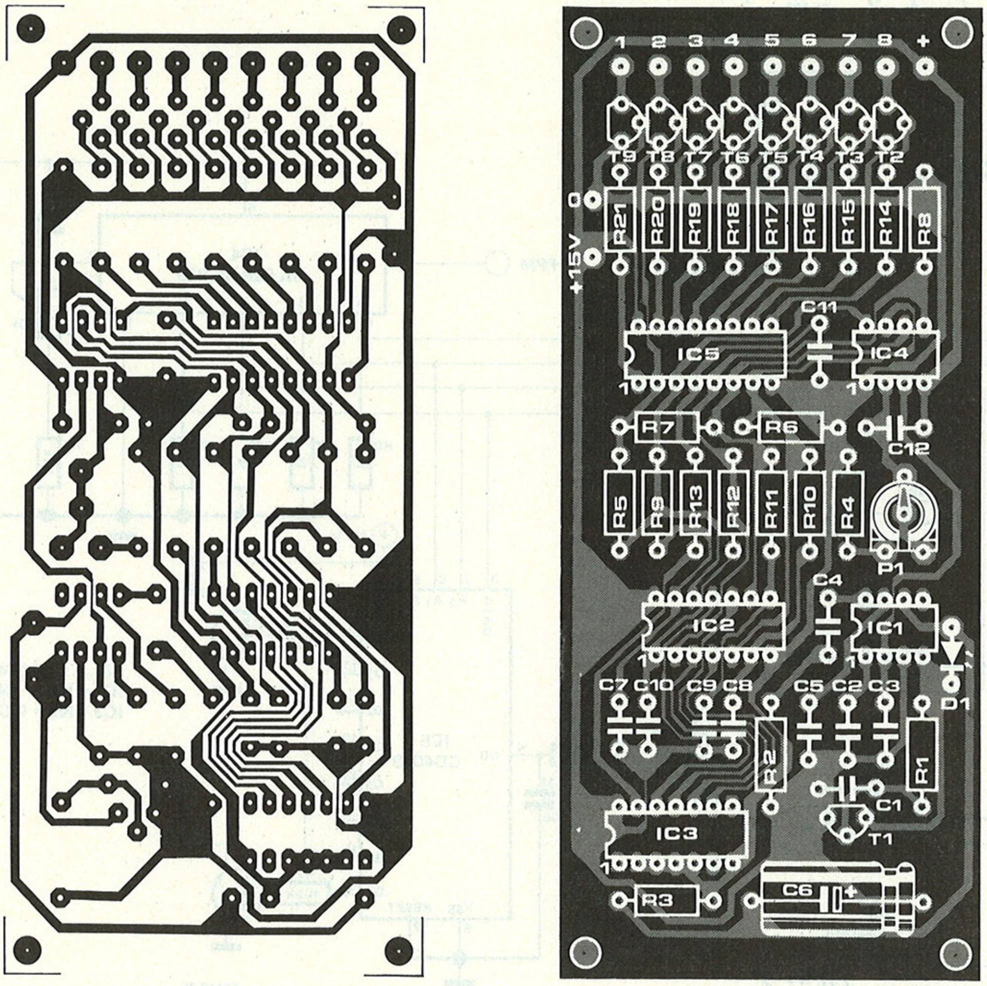


Figure 4.
A suggested printed circuit board design for the receiver. Outputs 1 to 8 can be connected by means of a multi-way socket.

binary code. The way Pin 2 is connected , together with the setting of P1, determines the oscillator frequency. ML928 reacts to codes from 00000 to 01111, with ML929 reacting to codes starting at 10000 and ending at 11111. This is ideal for our purposes.

In order to control a total of 16 functions both ICs are needed. Only one decoder is required when only 8 functions are sufficient. In this case, care must be taken to ensure that the correct codes are allocated which correspond to the keys being used. An allocation can easily be derived from the keyboard matrix shown in figure 1.

The 5-bit code is transmitted in the sequence E-D-C-B-A and interpreted by the receiver accordingly. Column E denotes which of the two ICs it is meant for ('0', ML928, '1' ML929); D supplies the 'on' or 'off' information; C, B and A contain the information for which of the 8 functions is to be connected.

The decoding circuit constructed around IC5 converts the code into switching pulses for T2 . . . T9. IC2 and IC3, produce the 'write disable' (WD) pulse for IC5. The EXOR gates register any level changes at the inputs; DATA, A2, A1 and A0. The NOR gate, situates a logic '0' at the WD input. The allocation of the binary codes to the outputs of IC5 and to the switching outputs, is infact, mirrored! This is simply because, IC4 is supplied with a negative operating voltage, enabling it to also function with negative logic. That means, output Q6 and not Q1 is used when the data '001' is situated at A0 . . . A2. Consequently, the switching signal at the DATA input will reach T8 via output Q6. The WD input will be logic '1' and the data input will be blocked when no further switching information is on the inputs of IC5. The outputs are not affected.

Construction, calibration, application

We advise constructors to build the circuits with printed circuit boards, the design of which are shown in figure 3 and 4. Unfortunately, due to unforseen circumstances we are unable to supply ready made ones from our EPS service. However, we feel certain that this will not prove to be a stumbling block for our readers.

The transmitter diodes are equipped with reflectors, which improve the light beam intensity, making it possible to control devices from a range of 8 to 10 metres.

Parts list figure 4

Resistors:
R1, R14 . . . R21 = 100 k
R2 = 82 k
R3 = 560 Ω
R4 = 22 k
R5 . . . R8 = 1 k
R9 . . . R12 = 68 k
R13 = 15 k
P1 = 50 k trimmer

Capacitors:
C1 = 47 n
C2,C4 = 100 n
C3 = 82 p
C5 = 2n2
C6 = 47 µ/25 V
C7 . . . C10 = 470 p
C11 = 150 p
C12 = 22 n

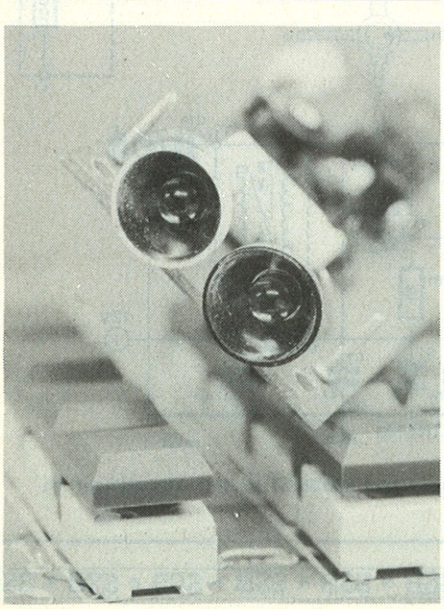
Semiconductors:
D1 = BPW 41
T1 = BC 560
T2 . . . T9 = BC547B
IC1 = SL 480 (Plessey)
IC2 = 4030
IC3 = 4002
IC4 = ML 928/ML 929
IC5 = 4099

Parts list figure 6

Capacitors:
C1 = 330 µ/25 V
C2 = 330 n
C3 = 100 n

Semiconductors:
B1 = B40C800
IC1 = 78L15

Miscellaneous:
Tr = 16 V/0.1 A mains transformer
fuse 63 mA
two-pole mains switch



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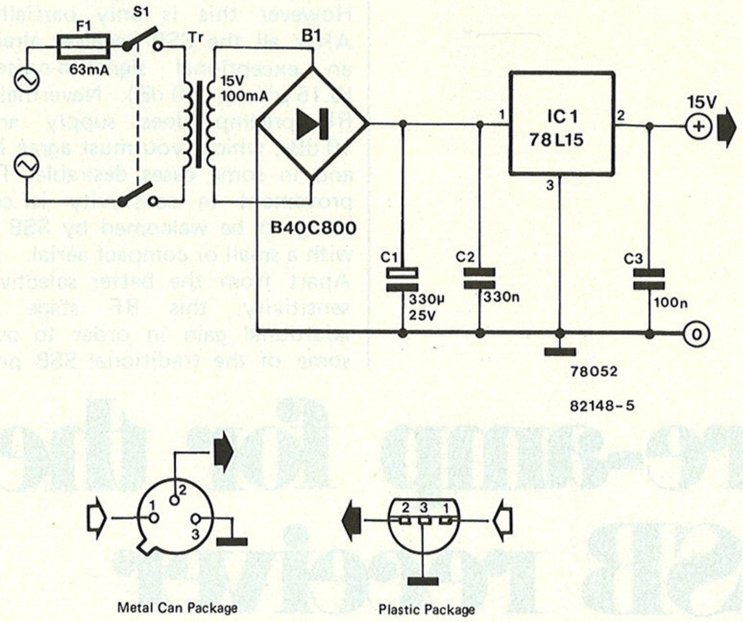

Figure 5. A simple power supply for the receiver.

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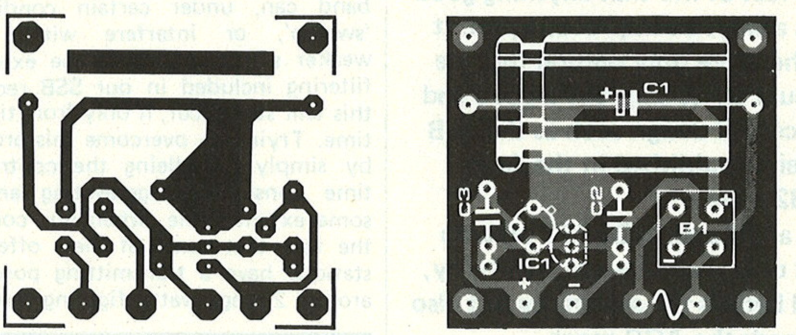

Figure 6. Design and component layout for the power supply board.

A keyboard can be built up on veroboard quite easily, and then inserted, together with the battery and circuit into a plastic case.

The receiver needs a 15 V supply. This can either be obtained from the equipment being controlled, such as the stereo system and so on, or from the power supply illustrated in figure 5. Where you install the receiver will depend on what is to be controlled. Obviously, anyone wishing to control more than one piece of equipment should house the receiver in a separate plastic case, and install separate or one multi-way socket.

The output signals from the unit are suitable for use with relays. As a matter of interest our June 1982 issue described a solid state relay which would be ideal for this application. We suggest the relay is placed near to, or actually inside the apparatus being controlled, as this means the use of low capacity connection wire, rather than thick obtrusive mains cable. Mechanical relays will require a protection diode connected the reverse way round. Any relay can be used which has a maximum coil voltage of 12 V and a resistance of around 150 Ω.

The calibration procedure is quite short. Set P1 of the transmitter to its mid position and depress a key (to switch something on). Now adjust P1 of the receiver until the relay is activated. Repeat the procedure a few times until you are satisfied that the relay is activated every time the key is depressed and that is it! ◀

pre-amp for the SSB receiver

boost the selectivity and sensitivity of your SSB.

In the normal course of events, it is a fact of life that anything good can always be improved upon. It is therefore only natural that we should try to improve a good and successful design such as the SSB receiver published in the June 1982 issue.

An additional MOSFET preamp not only increases the sensitivity, and betters the selectivity but also extends the AGC range.

Improvement just for the sake of change is not a philosophy followed by us. We therefore feel certain that SSB users, especially ones without access to large sophisticated aerial systems, are going to appreciate the little extra that the circuit introduced here gives.

Readers may be excused for jumping to the conclusion that the preamp is only useful for increasing the sensitivity. However this is only partially true. After all the SSB receiver already has an exceptional signal-to-noise ratio (0.15 µV at 10 dB). Nevertheless the RF preamp does supply an extra 10 dBs, which, you must agree is useful and in some cases desirable. This improvement in sensitivity is certainly going to be welcomed by SSB owners with a small or compact aerial.

Apart from the better selectivity and sensitivity, this RF stage supplies additional gain in order to overcome some of the traditional SSB problems.

Practise has shown that 'strong' transmitters operating within the 19 metre band can, under certain conditions, 'swamp', or interfere with, other weaker stations. Despite the extensive filtering included in our SSB receiver, this will still occur, if only from time to time. Trying to overcome this problem by simply twiddleing the controls is time consuming, aggravating and to some extent futile. When you consider the fact that some of these offending stations have a transmitting power of around 2 mega watts, fighting them off is harder than standing on the beach and trying to stop the tide. And everyone remembers what happened to the last man or king who tried that!

As David did with the proverbial Goliath, we have supplied a subtle and highly effective weapon in the form of an additional band-pass filter at the input of the RF stage. The band-width of this filter is 5000 kHz and together with the filters originally included in the SSB receiver, it provides adequate protection against the 'giants'. In effect the circuit becomes highly selective, thereby muting and damping the overbearing 19 metre transmitters, even when using large, sensitive aerials.

A further advantage of using the RF preamp relates to the ability of the receiver to handle and control high level input signals, (eliminate cross-modulation). Basically we are adapting the principle that the more amplification stages which are controlled by the AGC voltage are used the more effective the AGC will be.

As the AGC voltage controls the gain of the MOSFET, the result is to considerably extend the effective range of the AGC. In practice this increase is about 20 dBs! Strong signals adjacent to weak ones are now 'squeezed' a little more allowing the receiver to handle them much more easily. Consequently the receiver produces less noise when being tuned and has good station separation.

To summarise, the additional RF preamp enable the user to achieve;

- higher sensitivity.
- better selectivity.
- an extended AGC range.

The circuit diagram

Looking at figure 1 will show that a

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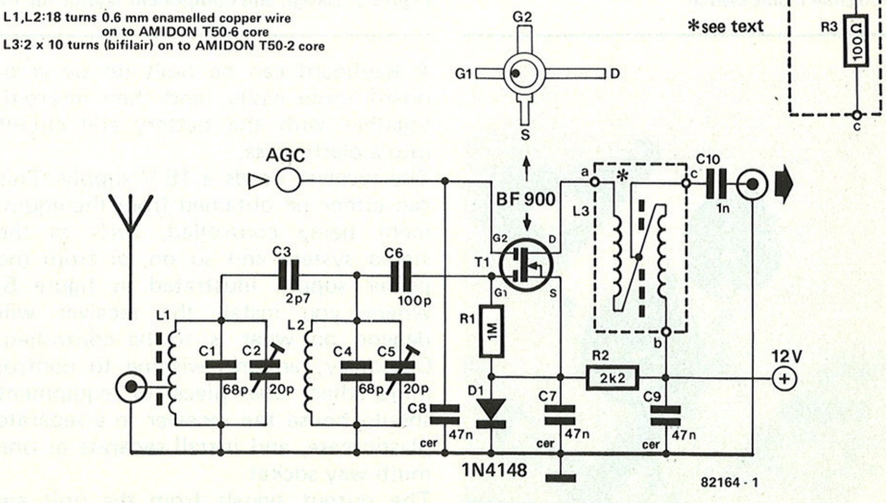

Figure 1. The preamplifier is constructed with a dual gate MOSFET bf 900. The difficult to wind coil, L3, can be replaced by a resistor R3.

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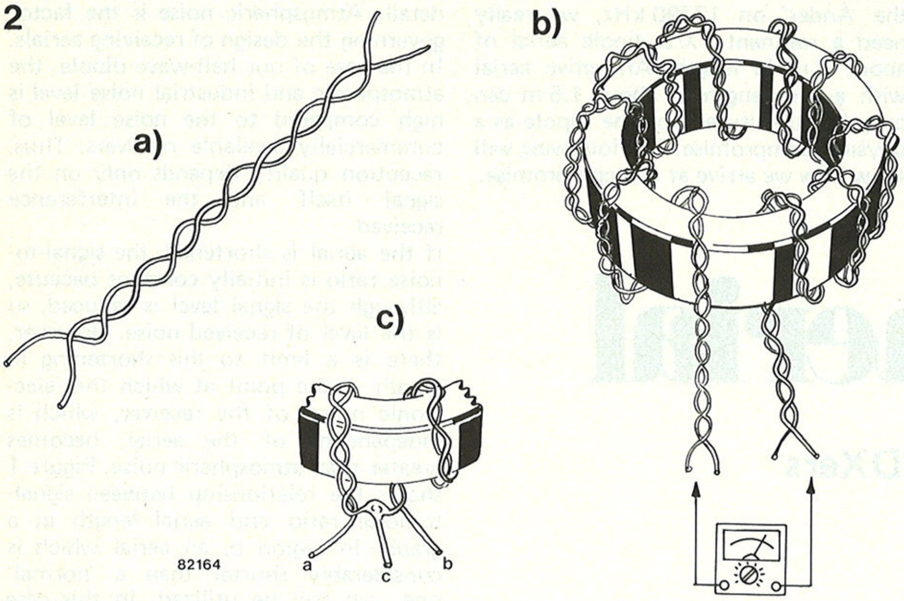


Figure 2. L3 is constructed as follows;
a. twist the wires together.
b. wind the result 10 times onto the core and find any two uncommon wires.
c. solder the two uncommon wires together to realise the centre tap. The other two ends are connections a and b.

dual gate MOSFET specifically type BF 900 is used as the active element of the preamp. Elektor readers who have already built or are thinking of building the SSB published in our June issue, will probably wonder why we are using the same type of MOSFET as we did before (for the RF, oscillator and mixer stage of the SSB). After all there are several other semiconductors which can be used to construct an excellent RF preamp for 14 MHz applications! Well the answer is quite simple. The BF 900 is easily available, inexpensive as far as MOSFET devices go, and experience has shown us that it is ideal for RF applications.

Returning to the circuit diagram, readers will note that a dual band-pass filter network is positioned at the input. This is made up of L1, L2, and C1 . . . C5. The dual gate MOSFET follows the filter enabling a 'classical' amplifier design to be constructed.

Gate 1 of T1 is connected to the voltage source via R1. The source voltage level is set by R2 and D1 to +0.6 V. The gain of T1 is varied by connecting the AGC voltage to gate 2. This is a positive voltage, the level of which depends on the strength of the input signal. The stronger the input signal, the lower the gain factor. Therefore with a higher voltage across gate 1 than gate 2 a considerable reduction in gain is achieved. With weak signals, maximum gain is effected (about 10 dBs), thus increasing the sensitivity from 0.15 μV to 0.05 μV with a signal-to-noise ratio of 10 dBs. The amplified signal is taken from the drain of T1 via a double wound (bifilar) coil L3. Constructors not fond of winding coils can replace L3 by a drain resistor. However this will effectively, if only, slightly reduce the sensitivity. The dotted line section below the main circuit diagram illustrates how the drain resistor is connected.

3

Typical curves resulting from various windings on the same core.

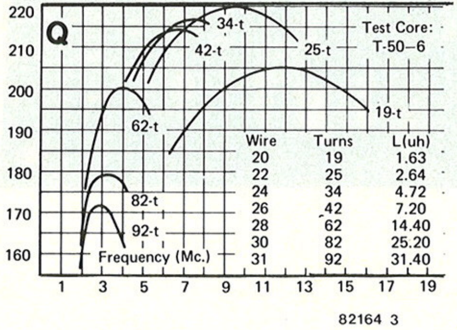


Figure 3. Toroidal core specifications of the original prototype, which used Amidon cores, together with the 'Q' chart.

type T50-6 permeability factor 8.
type T50-2 permeability factor 10.
dimensions of T50

outer dia.	inner dia.	height.	mean lenght.
.50 ins	.303 ins	.19 ins	3.20 cms.

Construction

Taking the simplicity of the circuit into consideration, constructing the preamplifier onto veroboard is relatively easy. The actual method adopted is not critical, but, you should take care that the connections to the MOSFET are as short as possible. This will ensure the good operation of T1.

Coils L1 and L2 are quite straight forward to wind. They both consist of 18 turns of 0.6 mm diameter copper wire, wound onto iron powder toroidal core formers, having an outer diameter of 0.5 ins. The prototype used toroids manufactured by Amidon Associates, but in case constructors have difficulty finding them, a complete specification is included in figure 3 to enable equivalents to be found. Apart from the physical dimensions please keep in mind that the completed coil should conform to the same 'Q' factor as the prototype, otherwise the performance will be impared.

When making the coils, you should ensure that the windings are evenly spaced to cover all of the core. In contrast to L2, L1 is tapped two winding up from the ground connection.

The construction of L3 is not straightforward and that is why we have devoted a separate section for it at the end of this article. Anyone not wishing to get involved with L3 can replace it with a drain resistor R3, but as already explained some of the performance is then lost.

We suggest inserting the completed circuit into the case of the SSB receiver, as any available space is suitable. Try and put it as close to the aerial connection of the RF section (of the SSB) as possible. The output of the preamp is connected to the aerial input on the SSB printed circuit board by means of coaxial cable. The link between the aerial bus and the preamp input should also be made with coax.

The AGC connection point on the SSB receiver board is clearly indicated and should not present problems. The supply voltage can be derived from the junction of L11 and L12 on the RF secttion.

Double windings (bifilary) of L3

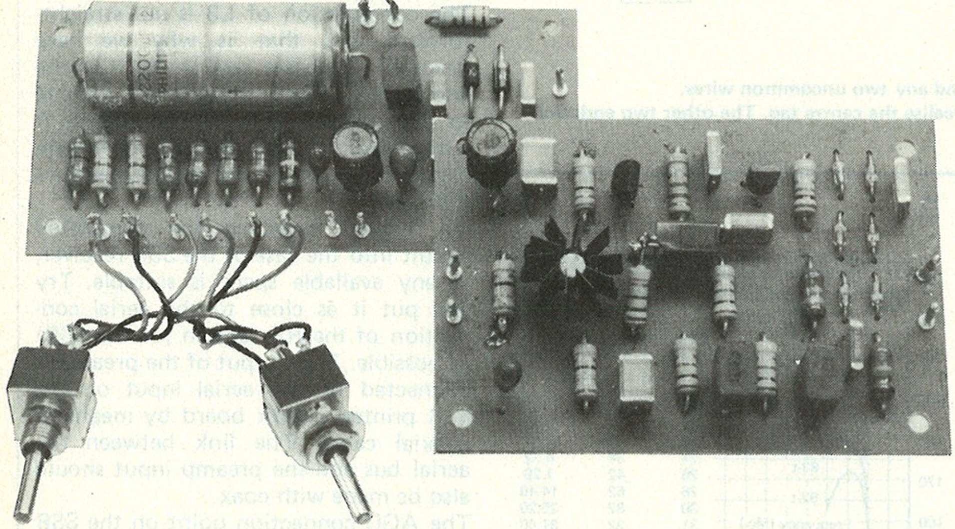
This coil consists of 10 double windings with centre tap, on a toroidal core (core specification see figure 3).

First of all two equal lengths of enamelled copper wire are twisted together as shown in figure 2a. The result should look like the old fashion two way flex. This double wire is now wound onto the ring core (10 windings), ensuring that the windings are evenly spaced over the whole core. Figure 2b clearly illustrates this procedure.

The next stage is to trim any excessive length of wire. Now, with the aid of an ohmmeter, or continuity tester, find any two uncommon wires (see figure 2b), an solder them together as shown in figure 2c. This in effect is the centre tap. The other two remaining wires are connections a and b of the coil as denoted in figure 1. ◼

active aerial

A short, active aerial for DXers



There it is, the new communications receiver. But how do we get it to pick up the "Voice of the Andes"? As the saying goes: a good aerial is still the best RF amplifier. However, the landlord will probably object to metres of wire and suspending the wire around the inside of the home will provoke the wrath of the family. A tangle of wire under the sofa is no solution either. What we need is an active aerial: it should be short and convenient to use whilst enabling good reception. An active antenna certainly cannot perform miracles. If, for example, we really do want to receive the "Voice of the Andes" on 17790 kHz, we really need a resonant 2/2 dipole aerial of about 8 m in length. An active aerial with a rod length of about 1.5 m can only be substituted fot the dipole as a physical compromise. The following will show how we arrive at this compromise.

An active antenna certainly cannot perform miracles. If, for example, we really do want to receive the 'Voice of the Andes' on 17790 kHz, we really need a resonant λ/2 dipole aerial of about 8 m in length. An active aerial with a rod length of about 1.5 m can only be substituted for the dipole as a physical compromise. The following will show how we arrive at this compromise.

Some radio principles

The problem involves an 'electrically short' receiving aerial for frequencies below 30 MHz, the hunting grounds of the short-wave DXer. But here is the paradox: how can an active aerial with a rod length of about 1.5 m be used over the frequency range of 1.5 – 30 MHz, in which we normally have to utilize half-wave dipoles of up to 95 m in length?

Here we have to go into a little more detail. Atmospheric noise is the factor governing the design of receiving aerials. In the case of our half-wave dipole, the atmospheric and industrial noise level is high compared to the noise level of commercially available receivers. Thus, reception quality depends only on the signal itself and the interference received.

If the aerial is shortened, the signal-to-noise ratio is initially constant because, although the signal level is reduced, so is the level of received noise. However, there is a limit to this shortening in length — the point at which the 'electronic noise' of the receiver, which is independent of the aerial, becomes greater than atmospheric noise. Figure 1 shows the relationship between signal-to-noise ratio and aerial length in a graph. In region b, an aerial which is considerably shorter than a 'normal' one, can still be utilized. In this case the received noise level is just as high as that of electronic noise.

Short aerials of this type are constructed as vertical aerials (rods or whips) and horizontal aerials (dipoles) for reception over the range 10 kHz to 30 MHz.

Matching

So far so good. But why can't we simply connect an aerial to the receiver in the form of a short rod? This can be best explained by figure 1. First of all, the signal level received by the aerial is not greatly reduced when the aerial is shortened. For example, a dipole which is short with respect to wavelength receives only 10% less signal level than the half-wave dipole. The problem is in the question of matching.

In figure 2, the aerial is represented as an AC voltage source with the characteristics R_A (= radiation resistance) and X_A (= reactance). At a constant frequency, the radiation resistance is proportional to the square of the length of the dipole. The reactance is inversely proportional to the length. This means that the shorter the aerial. the *greater* is the reactance. With a short dipole of 10 m overall length, for example, we have the following values at 1.5 MHz: R_A approximately 0.5 Ω and X_A a few kilohms. With proper *matching for the transfer of power,* however, this total impedance must be exactly the same as the input impedance of the receiver, (50 Ω). Considering the aerial itself as a voltage source, and as the impedance increases as it is shortened, then the consequences are severe. Feeding a high impedance unloaded voltage to a low impedance input of a receiver simply means that you will get absolutely nothing out! What is required is a proper match! With passive aerials, transformers are employed to correct the miss-match.

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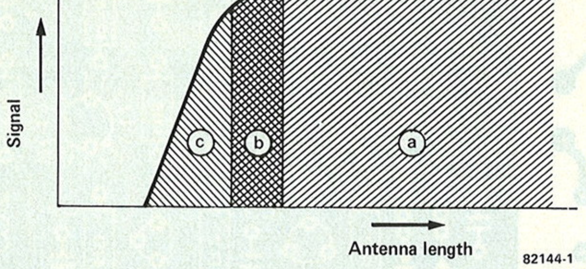

Figure 1. Signal-to-noise ratio as a function of absolute aerial length 1 at a constant frequency, a = region in which the level of atmospheric noise is higher than that of internal noise; b = region in which the level of atmospheric noise is close to that of internal noise; c = region in which the level of internal noise exceeds that of atmospheric noise.

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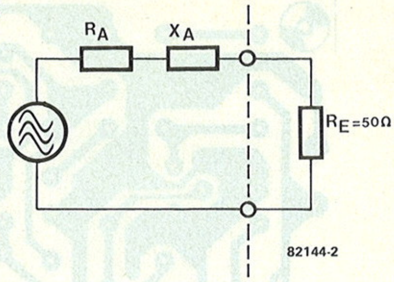

Figure 2. Matching conditions at the aerial output. Equivalent circuit of the aerial: AC voltage generator, R_A = radiation resistance, X_A = reactance. Receiver input impedance: R.

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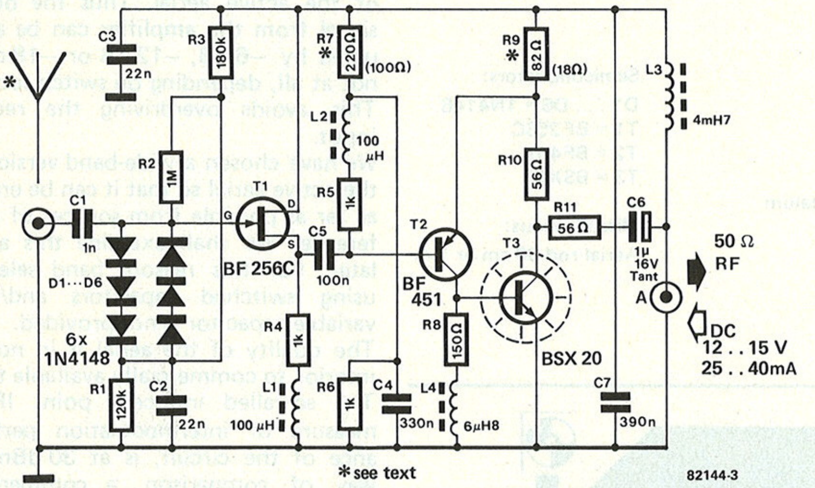

Figure 3. The 'active' part of the aerial consists of impedance transformation stage with T1 and amplification stage with T2/T3. The circuit is 'remote-powered' via the output and L3.

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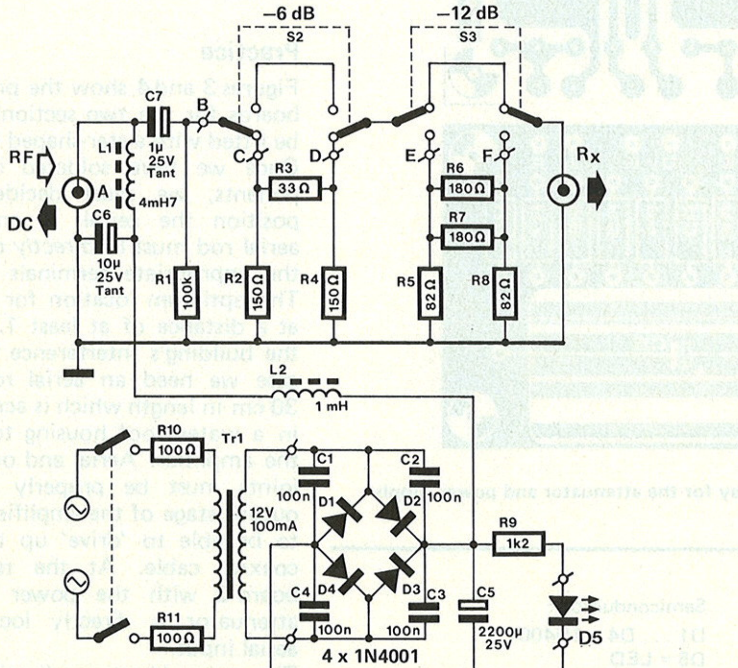


Figure 4. Power supply and attenuator of the active aerial system. The DC voltage is fed into the coaxial cable to the amplifier via L1/L2/C6. Four attenuation stages can be selected with S2 and S3.

Using this technique on active aerials would also work, but, only over a narrow frequency range.

The solution to our problem is really quite simple! The short high impedance aerial is first of all connected to an amplifier which also has a high impedance input. Thus the unloaded voltage from the source (aerial), is not destroyed. Matching the receiver to the amplifier is achieved by providing the amplifier with a low impedance output.

To summarize, therefore: the secret of the active aerial is that when the short aerial (short with respect to wavelength) is properly matched to a receiver (using an amplifier stage), it delivers exactly the same reception results as its big brother. An added benefit is that it provides advantages in DX reception. The theoretical explanation would be beyond the scope of this article, but it is true to say that from a technical viewpoint, active aerials are a good compromise between high sensitivity and short dimensions.

The active aerial

The active aerial consists of three parts: impedance transformer and amplifier, power supply, attenuator (see figure 3). The RF part of the active aerial is designed around transistors T1-T3. The passive part, the aerial rod, is applied directly to the gate of field effect transistor T1 via coupling capacitor C1. T1 is configured as a source follower, resulting in the desired performance as an impedance transformer (high input impedance, low output impedance). T2/T3 form a two-stage RF amplifier whose amplification is adjusted by R7 and R9. The amplification can be increased is necessary by varying R7 and R9. In this case, the values in parentheses apply.

The circuit is powered by the remote power supply consisting of Tr1, the bridge rectifier and C5 (see figure 4). The DC voltage is applied to the output of the amplifier via L1/L2/C6. The DC voltage reaches the amplification stages via L3.

The attenuation stages which are selected with S2 and S3 form the third part

5

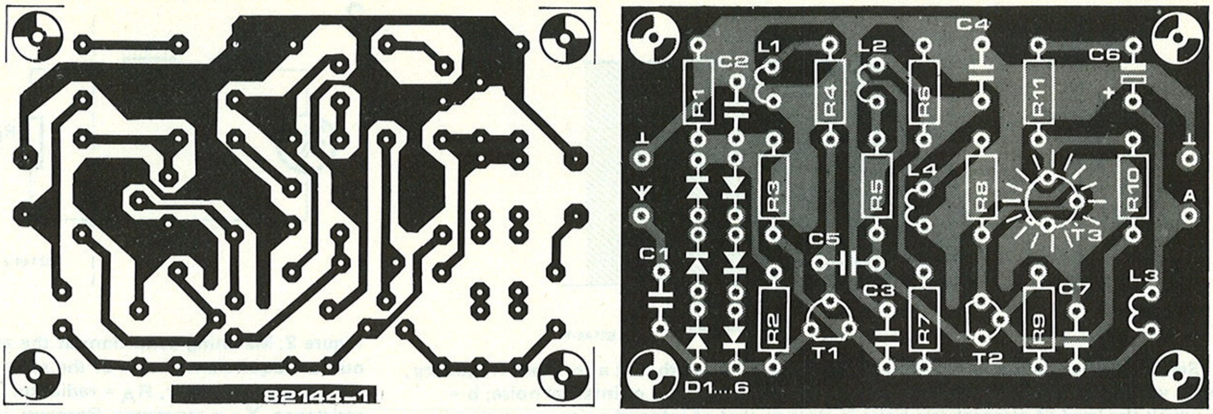


Figure 5. Printed circuit board and component overlay for the RF part of the active aerial. T3 is fitted with a star-shaped heatsink.

Parts list for figure 5

Resistors:
R1 = 120 k
R2 = 1 M
R3 = 180 k
R4 . . . R6 = 1 k
R7 = 220 Ω (100 Ω)
R8 = 150 Ω
R9 = 82 Ω (18 Ω)
R10,R11 = 56 Ω

Capacitors:
C1 = n
C2,C3 = 22 n
C4 = 330 n
C5 = 100 n
C6 = 1 µ/16 V tantalum
C7 = 390 n

Coils:
L1,L2 = 100 µ
L3 = 4m7
L4 = 6µ8

Semiconductors:
D1 . . . D6 = 1N4148
T1 = BF256C
T2 = BF451
T3 = BSX20

Miscellaneous:
Aerial rod 30 cm or 1 m

6

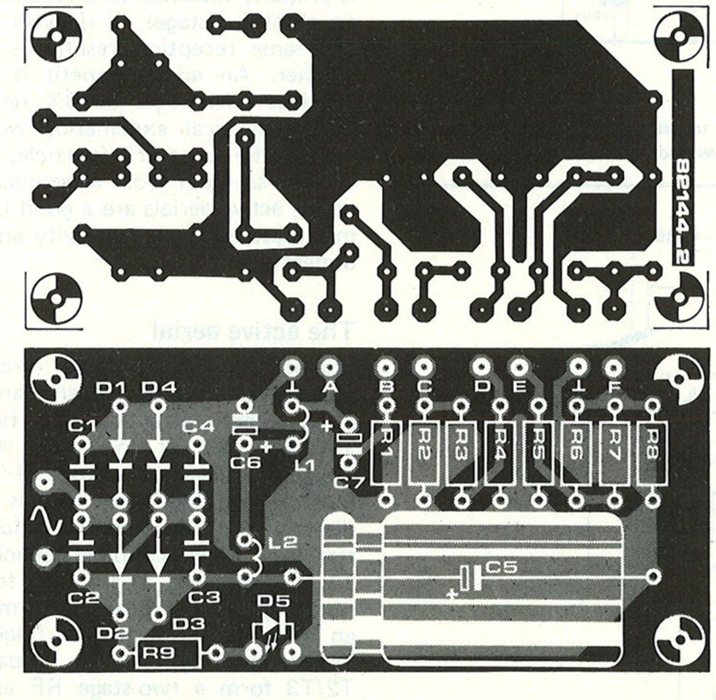


Figure 6. Printed circuit board and component overlay for the attenuator and power supply of the active aerial.

Parts list for figure 6

Resistors:
R1 = 100 k
R2,R4 = 150 Ω
R3 = 33 Ω
R5,R8 = 82 Ω
R6,R7 = 180 Ω
R9 = 1k2
R10,R11 = 100 Ω

Capacitors:
C1 . . . C4 = 100 n
C5 = 2200 µ/25 V
C6 = 10 µ/25 V tantalum
C7 = 1 µ/25 V tantalum

Coils:
L1 = 4m7
L2 = 1 m

Semiconductors:
D1 . . . D4 = 1N4001
D5 = LED

Miscellaneous:
S1 = two-pole mains switch
S2,S3 = two-pole changeover switch
Tr1 = mains transformer, 12 V/100 mA secondary

of the active aerial. Thus the output signal from the amplifier can be attenuated by −6 dB, −12 dB or −18 dB or not at all, depending on switch settings. This avoids overdriving the receiver input.

We have chosen a wide-band version for the active aerial so that it can be erected as far as possible from sources of interference. We shall examine this aspect later. For this reason, band selection using switched capacitors and/or a variable capacitor is not provided.

The quality of the aerial is in no way inferior to commercially available types. The so-called intercept point IP3, a measure of intermodulation performance of the circuit, is at 30 dBm. By way of comparison, a commercially available aerial (AD-270/370) exhibits the same value. The frequency range extends from 3 kHz to 100 MHz (−3 dB) with T2/T3 providing a gain of 11 dB!

Practice

Figures 3 and 4 show the printed circuit boards for the two sections. T3 should be fitted with a star-shaped heatsink.

Once we have soldered in the components, we must decide where to position the aerial. In any case, the aerial rod must be *directly* connected to the appropriate terminals on board 1. The optimum location for the aerial is at a distance of at least 1.5 m beyond the building's interference field. In this case we need an aerial rod of about 30 cm in length which is accommodated in a waterproof housing together with the amplifier. Aerial and output socket joints must be properly sealed. The output stage of the amplifier is designed to be able to 'drive' up to 100 m of coaxial cable. At the receiver end, board 2 with the power supply and attenuator is directly located at the aerial input.

The second-best application for the active aerial is indoors. In this case, both printed circuit boards and the aerial rod (now 1 m in length) can be installed in a housing.

Now all that is left is to try it out. Have fun and good DXing. ⏮

TRANSISTORS SURVEY: AF and general-purpose types.

type	PNP NPN	max U_{CEO} (V)	max I_c (mA)	P_{max} (mW)	h_{FE}/I_c	(mA)	compl.	fig.	
BC 107	N	45	100	300	>110	2	BC 177	1	
BC 108	N	20					BC 178	1	
BC 109	N						BC 179	1	
BC 140	N	40	1000	3700	>40	100	BC 160	1	
BC 141	N	60					BC 161	1	
BC 160	P	40					BC 140	1	
BC 161	P	60					BC 141	1	
BC 177	P	45	100	300	>70	2	BC 107	1	
BC 178	P	25					BC 108	1	
BC 179	P	20			>110		BC 109	1	
BC 182	N	50	200		>100		BC 212	2	
BC 183	N	30					BC 213	2	
BC 184	N						BC 214	2	
BC 212	P	50			>60		BC 182	2	
BC 213	P	30			>80		BC 183	2	
BC 214	P				>140		BC 184	2	
BC 237	N	45	100		>110		BC 307	2	
BC 238	N	20					BC 308	2	
BC 239	N		50				BC 309	2	
BC 307	P	45	100		>70		BC 237	2	
BC 308	P	25					BC 238	2	
BC 309	P	20	50				BC 239	2	
BC 327	P	45	500	800	>100	100	BC 337	2	
BC 328	P	25					BC 338	2	
BC 337	N	45					BC 327	2	
BC 338	N	25					BC 328	2	
BC 414	N	50	100	300	>100	2	–	2	
BC 416	P				>120		–	2	
BC 516	P	30	400	625	>30.000	20	BC 517	2	1)
BC 517	N						BC 516	2	1)
BC 546	N	65	100	500	>110	2	BC 556	2	
BC 547	N	45					BC 557	2	
BC 548	N	30					BC 558	2	
BC 549	N				>200		–	2	
BC 550	N	45					–	2	
BC 556	P	65			>75		BC 546	2	
BC 557	P	45					BC 547	2	
BC 558	P	30					BC 548	2	
BC 559	P				>125		–	2	
BC 560	P	45					–	2	
BC 639	N	80	1000	1000	>40	150	BC 640	3	
BC 640	P						BC 639	3	

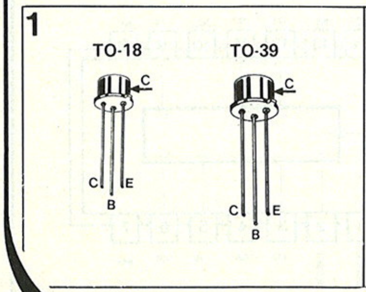
Notes:

1) darlington

2) max. U_{CEO}:
. . . A = 60 V
. . . B = 80 V
. . . C = 100 V

type	PNP NPN	max U_{CEO} (V)	max I_c (A)	P_{max} (W)	h_{FE}/I_c		compl.	fig.	
BD 131	N	45	3	15	>40	0,5A	BD 132	4	
BD 132	P						BD 131	4	
BD 135	N		1	8		0,15A	BD 136	4	
BD 136	P						BD 135	4	
BD 137	N	60					BD 138	4	
BD 138	P						BD 137	4	
BD 139	N	80					BD 140	4	
BD 140	P						BD 139	4	
BD 169	N		1,5	20			BD 170	4	
BD 170	P						BD 169	4	
BD 183	N		15	117	>20	3 A	–	5	
BD 233	N	45	2	25	40	0,15A	BD 234	4	
BD 234	P						BD 233	4	
BD 235	N	60					BD 236	4	
BD 236	P						BD 235	4	
BD 237	N	80					BD 238	4	
BD 238	P						BD 237	4	
BD 239	N	45	2	30		0,2 A	BD 240	6	2)
BD 240	P						BD 239	6	2)
BD 241	N		3	40	>25	1 A	BD 242	6	2)
BD 242	P						BD 241	6	2)
BD 243	N		6	65	>30	0,3 A	BD 244	6	2)
BD 244	P						BD 243	6	2)
BD 245	N		10	80	>40	1 A	BD 246	7	2)
BD 246	P						BD 245	7	2)
BD 249	N		25	125	>25	1,5 A	BD 250	7	2)
BD 250	P						BD 249	7	2)
BD 435	N	32	4	36	>85	0,5 A	BD 436	4	
BD 436	P						BD 435	4	
BD 437	N	45					BD 438	4	
BD 438	P						BD 437	4	
BD 439	N	60			>40		BD 440	4	
BD 440	P						BD 439	4	
BD 441	N	80					BD 442	4	
BD 442	P						BD 441	4	
BD 643	N	45	8	62,5	>750	3 A	BD 644	7	1)
BD 644	P						BD 643	7	1)
BD 645	N	60					BD 646	7	1)
BD 646	P						BD 645	7	1)
BD 675	N	45	4	40		1,5 A	BD 676	4	1)
BD 676	P						BD 675	4	1)
BD 677	N	60					BD 678	4	1)
BD 678	P						BD 677	4	1)
BD 679	N	80					BD 680	4	1)
BD 680	P						BD 679	4	1)
TIP 31	N	40	3	40	>20	0,5 A	TIP 32	6	2)
TIP 32	P						TIP 31	6	2)
TIP 33	N		10	80			TIP 34	7	2)
TIP 34	P						TIP 33	7	2)
TIP 35	N		25	125	>25	1 A	TIP 36	7	2)
TIP 36	P						TIP 35	7	2)
TIP 41	N		6	65	>20	0,5 A	TIP 42	6	2)
TIP 42	P						TIP 41	6	2)
TIP 122	N	100	8		>1000		TIP 127	6	1)
TIP 127	P						TIP 122	6	1)
TIP 142	N		15	125		5 A	TIP 147	7	1)
TIP 147	P						TIP 142	7	1)
TIP 2955	P	70	15	100	>20	4 A	TIP 3055	7	
TIP 3055	N						TIP 2955	7	
2N3055	N			115			MJ 2955	5	
MJ 2955	P						2N3055	5	
2N 2955	*P*	*25*	*100 m*	*0,3*	*>20*	*10 mA*	–	*1*	

1



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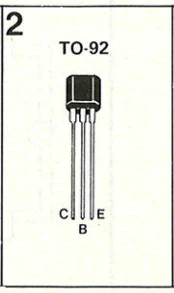

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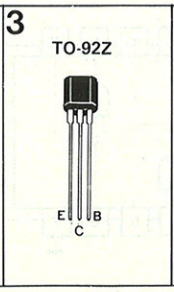

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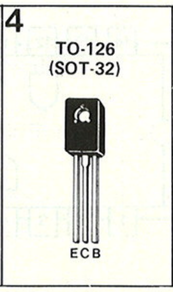

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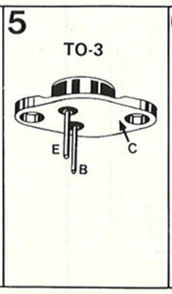

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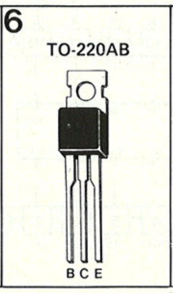

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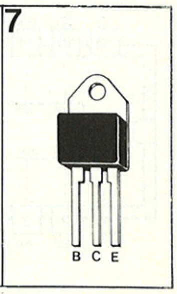
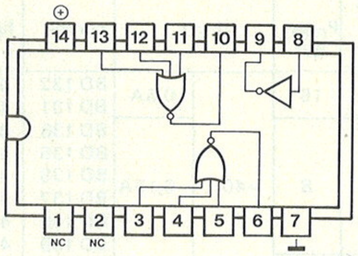


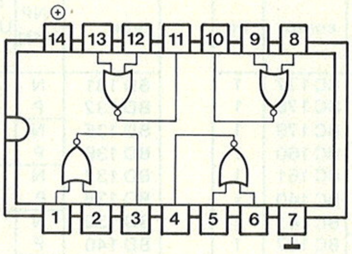
DUAL 3-INPUT NOR-GATE PLUS INVERTER

4000



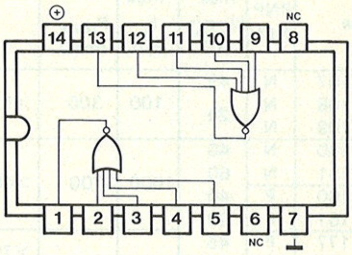
QUADRUPLE 2-INPUT NOR GATE

4001



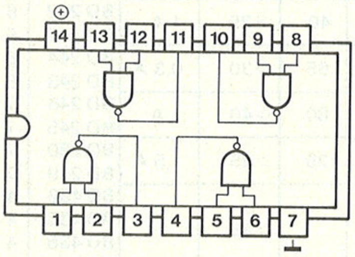
DUAL 4-INPUT NOR-GATE

4002



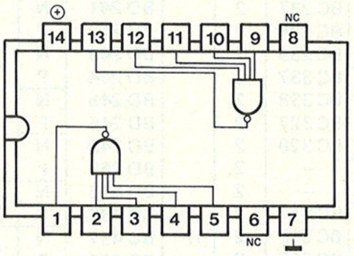
QUADRUPLE 2-INPUT NAND GATE

4011



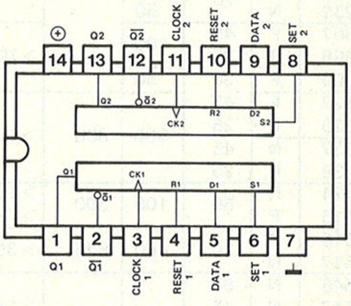
DUAL 4-INPUT NAND GATE

4012



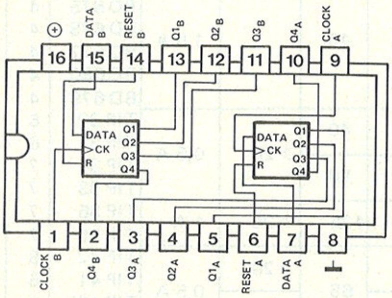
DUAL D-FLIP-FLOP

4013



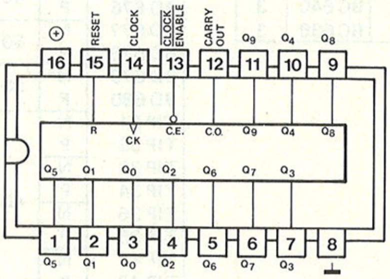
DUAL 4-BIT STATIC SHIFT REGISTER

4015



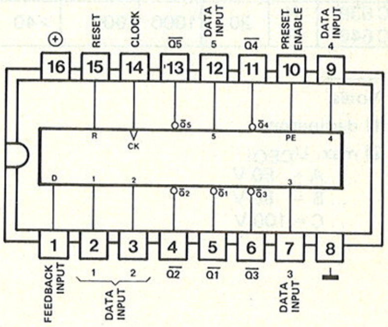
DECADE COUNTER/DIVIDER

4017



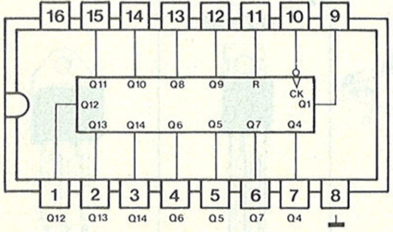
SYNCHRONOUS PRESETTABLE DIVIDE BY 'N'COUNTER

4018



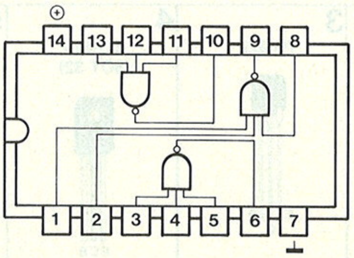
14-BIT BINARY RIPPLE COUNTER

4020



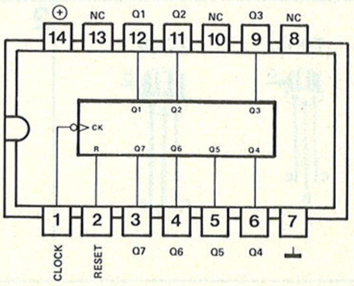
TRIPLE 3-INPUT NAND-GATE

4023



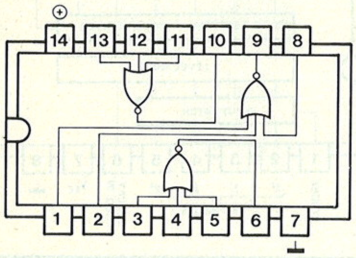
7-STAGE BINARY RIPPLE COUNTER

4024



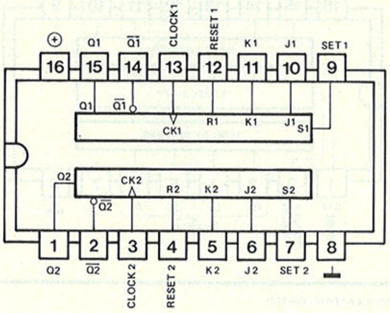
TRIPLE 3-INPUT NOR-GATE

4025



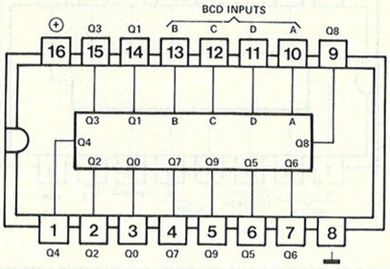
DUAL JK-FLIP-FLOP

4027



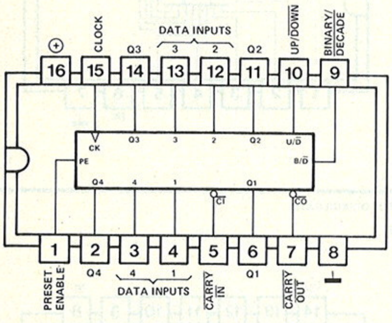
BCD-TO-DECIMAL DECODER

4028



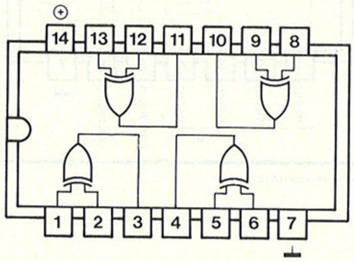
SYNCHRONOUS PRESETTABLE BINARY/DECADE UP/DOWN COUNTER

4029



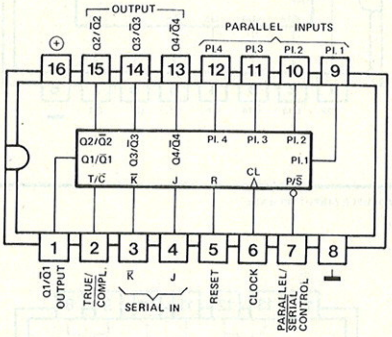
QUADRUPLE 2-INPUT EXCLUSIVE-OR-GATE

4030
4070 low power TTL compatible (fan out = 2)



4-BIT PARALLEL-IN/PARALLEL-OUT SHIFT REGISTER

4035



12-BIT BINARY RIPPLE COUNTER

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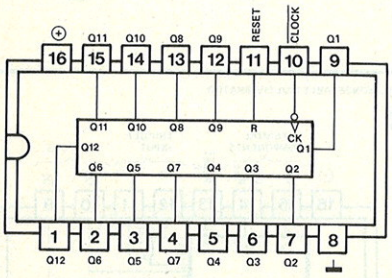
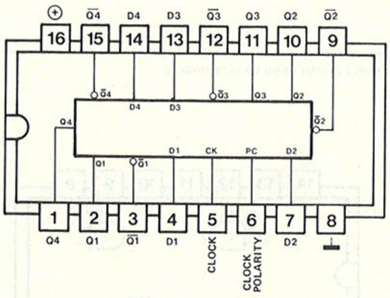


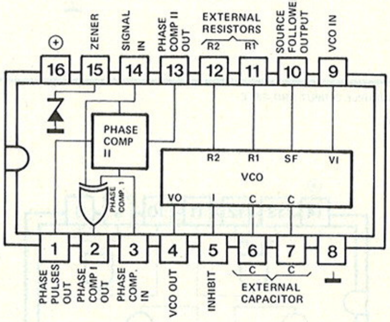
QUAD CLOCKED "D" LATCH

4042



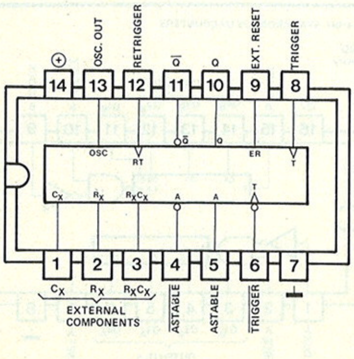
MICROPOWER PLL

4046



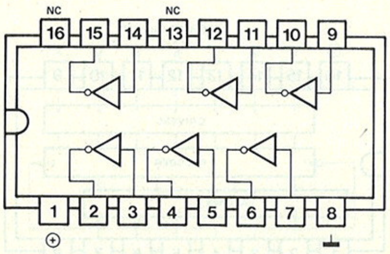
MONOSTABLE/ASTABLE MULTIVIBRATOR

4047



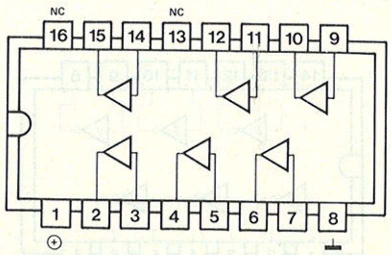
HEX INVERTING BUFFER

4049



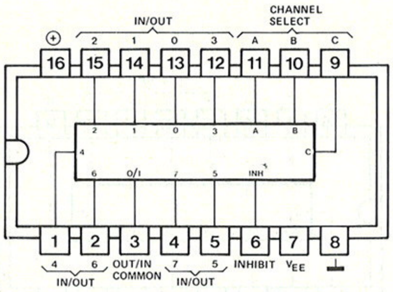
HEX BUFFER

4050



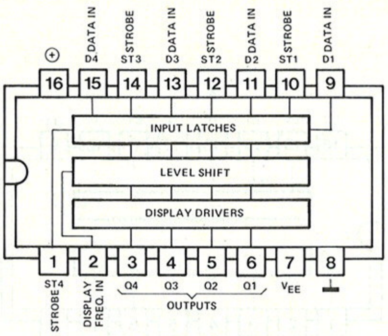
8 CHANNEL ANALOG MULTIPLEXER/DEMULTIPLEXER

4051



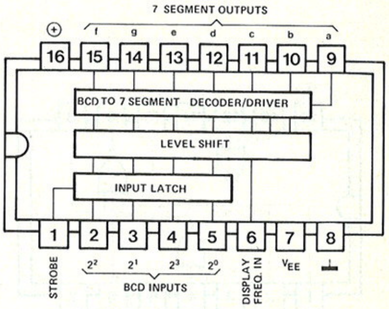
4-SEGMENT LCD DRIVER

4054



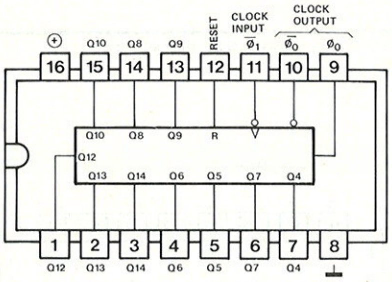
BCD TO 7-SEGMENT DECODER/LCD DRIVER

4056



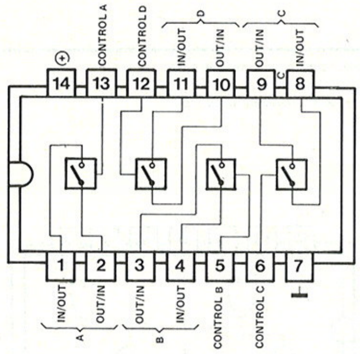
14-STAGE BINARY RIPPLE COUNTER AND OSCILLATOR

4060



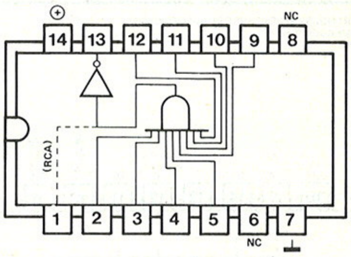
QUAD BILATERAL SWITCH

4016
4066



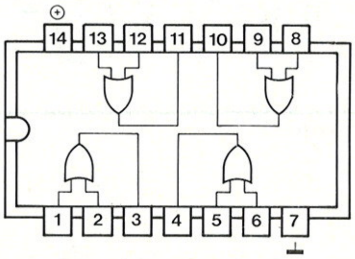
8 INPUT AND/NAND GATE

4068



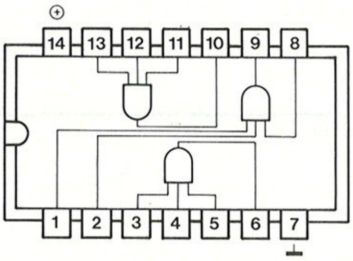
QUADRUPLE 2-INPUT OR-GATE

4071



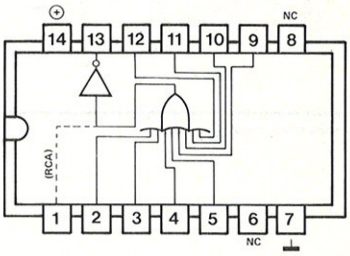
TRIPLE 3-INPUT AND GATE

4073



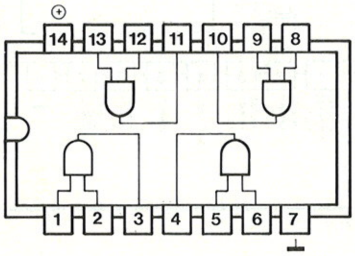
8 INPUT OR/NOR GATE

4078



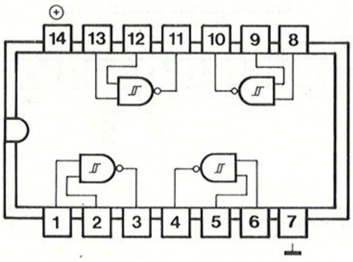
QUADRUPLE 2-INPUT AND-GATE

4081



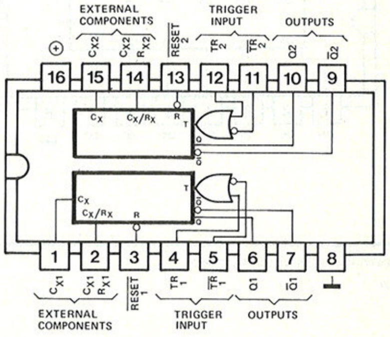
QUADRUPLE 2-INPUT NAND SCHMITT-TRIGGER

4093



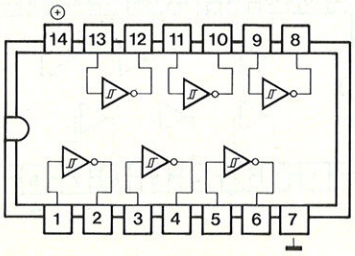
DUAL MONOSTABLE MULTIVIBRATOR

4098
4528



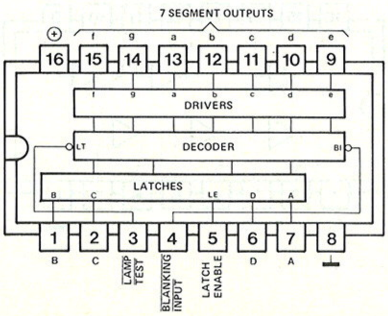
HEX SCHMITT-TRIGGER

40106



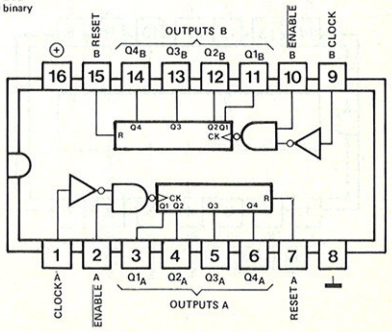
BCD TO 7-SEGMENT LATCH/DECODER/DRIVER

4511

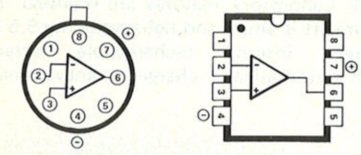


DUAL 4-BIT SYNCHRONOUS UP-COUNTERS

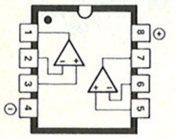
4518 BCD
4520 binary



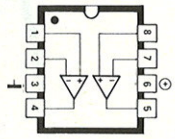
Linear ICs



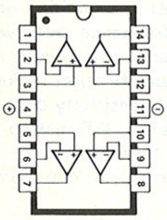
301
318
709
741
CA 3130
CA 3140
LF 355/356/357
TL 071/081



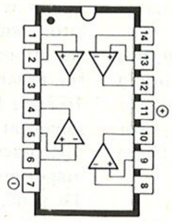
1458
4558



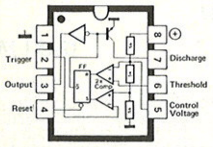
LM 387
NE 542



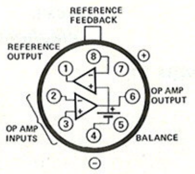
LM 324
TL 074
TL 084



RC 4136

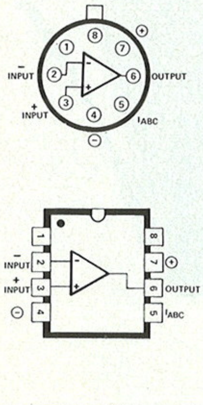


555

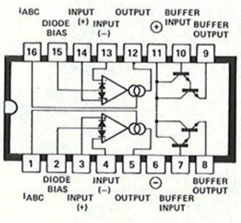


LM 10C

CA 3080



LM 13600

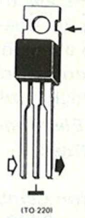


Input ⇨

Output ➡

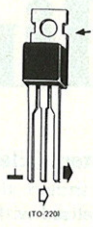
All ICs shown top view

Voltage Regulators



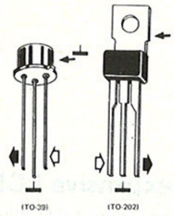
7805
7806
7808
7812
7815
7818
7824

I_{out} = 1 A



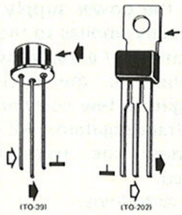
7905
7906
7908
7912
7915
7918
7924

I_{out} = −1 A



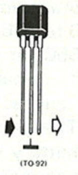
78M05
78M06
78M08
78M12
78M15
78M18
78M24

I_{out} = 500 mA



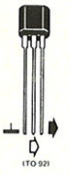
79M05
79M06
79M08
79M12
79M15
79M18
79M24

I_{out} = −500 mA



78L05
78L06
78L08
78L12
78L15
78L18
78L24

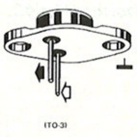
I_{out} = 100 mA



79L05
79L06
79L08
79L12
79L15
79L18
79L24

I_{out} = −100 mA

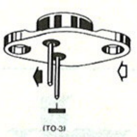
U_{out} = 5 V



LM 309K
I_{out} = 1 A

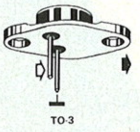
LM 323K
I_{out} = 3 A

U_{out} = −5 V



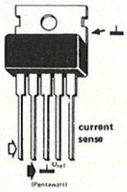
I_{out} = −3 A

U_{out} = 1,2 V . . . 37 V



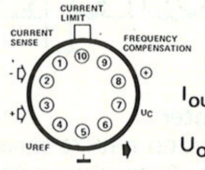
LM 317K
I_{out} = 1,5 A

U_{out} = 2,85 V . . . 40 V



L 200
I_{out} = 2 A

LM 723



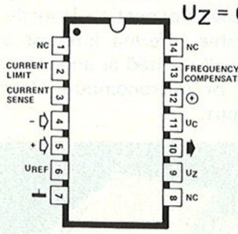
(pas de U_Z)

I_{out} = 200 mA

U_{out} = . . . 37 V_{max}.

U_{ref} = 7,15 V

U_Z = 6,2 V



Operating Voltage Range

7805 = 8 V . . . 35 V
7806 = 9 V . . . 35 V
7808 = 11 V . . . 35 V
7812 = 15 V . . . 35 V
7815 = 18 V . . . 35 V
7818 = 21 V . . . 35 V
7824 = 27 V . . . 40 V

7905 = −8 V . . . −35 V
7906 = −9 V . . . −35 V
7908 = −11 V . . . −35 V
7912 = −15 V . . . −35 V
7915 = −18 V . . . −35 V
7918 = −21 V . . . −35 V
7924 = −27 V . . . −40 V

missing link

Home telephone system (Elektor 89)

Extensive tests have shown that improved performance can be realised with a few minor modifications regarding the power supply of the home telephone system. In short, it means lowering the power supply output to 5 V. This really only applies to those systems where a large number of extensions are in use. The modifications to the circuit consist simply of changing a few component values and IC1, the voltage regulator. All other components, including the transformer, can remain unchanged.

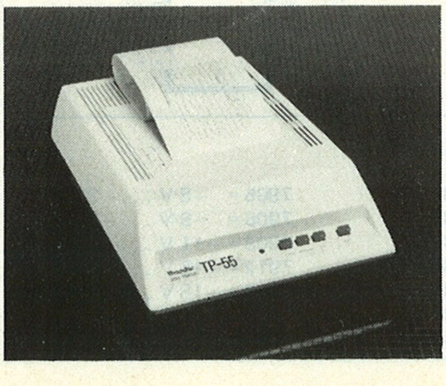
The changes are as follows:

R7 = 8k2
R16 = 1 k
R18 = 33 k
R19 = 10 k
R21 = 820 k
D7 = AA119
IC7 = 7805

market

Video printer

The TP55 VIDEO PRINTER, now available from Thandar Electronics can be connected to any standard video source to provide an instant hard copy record print. Operating in response to a composite video signal, it needs no interface. Connection is made via a single coaxial cable offering limitless applications. It is especially suited as an accessory for logic analysers, or microcomputer terminals, with video output.



All information appearing on the CRT, can be copied quickly and efficiently without modification. Both positive and negative prints can be provided. Compact and lightweight, the electrosensitive dot matrix printer is simple to operate and maintain, printing out on to a 5 inch paper roll at 12 seconds per picture (normal resolution) or 24 seconds per picture (high resolution).

Thandar Electronics Limited,
London Road,
St Ives,
Huntingdon Cambs.
Telephone: 0480.64646

(2483 M)

Inexpensive LCD multi-testers

Three new LCD digital multi-testers are announced by Semiconductor Supplies, Sutton. These compact, rugged units with 3½ digit LCD readouts have carrying cases and probes and are guaranteed for a year. Prices range from £23.10 to £36.05 (plus VAT).

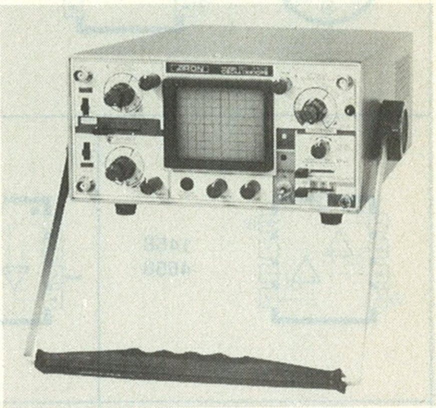
Model KD-55C, at the top of the range, has twenty-eight measuring ranges including 10 amps dc and ac and a foldaway stand for bench use. The display includes polarity, over range, low battery overload indicators. There is automatic zeroing on all ranges.

Semiconductor Supplies Internation Ltd.,
Dawson House,
128/130 Carshalton Road,
Sutton, Surrey,
SM1 4RS.
Telephone: 01.643.1126

(2484 M)

Portable oscilloscope

Now available from Matron is the BS-310S dual trace oscilloscope. It is a portable instrument designed for service applications and will double successfully as a bench scope as full Laboratory features are retained. The instrument is small and light weighing 5.5 kgs including internal rechargeable batteries which automatically charge whenever mains power is supplied. A built-in switching regulator ensures stable performance over wide variations in mains voltage and frequency and for external DC input. Specification includes 15 MHz bandwidth, 2 mV sensitivity chop-alt selection, trace add-substract, 0.5 secs to 0.5 microsecs per division timebase with X5 magnifier and variable control, X-Y mode and TV sync.



Martron Ltd.,
20 Park Street,
Princes Risborough,
Bucks.
Telephone: 08444.4321

(2481 M)

market

Selective-call module

Emu Systems Limited has developed a high quality Selective Calling device with many unique features ideally suited for the CB market. The Emu Selcall's main advantage is its ability to transmit and receive on two different codes, allowing for far greater flexibility when more than two units are in use.

The receive code is programmed internally, whilst the transmit code is selected by three thumb-wheel switches mounted on the front panel.

Other features include:

1. The ability to mute/unmute the rig by momentarily depressing the Push to Talk switch.
2. A message received light indicates that the unit has been activated during the user's absence, thus requiring a return call.
3. Very short transmit period of typically 100 ms (about one tenth of a second), an exceptionally important point when comparing with other units that require a total silent period on channel of between 5 and 7 seconds. This means that there is little chance of another person corrupting the coded information whilst transmitting.
4. 820 different coded tone bursts are available for use on each channel.

Like all other Emu CB accessories, the Selective Call Unit plugs directly into the microphone socket on the rig, with no need to make any internal alterations. Another feature avoids the need to hold the Unit on or near loudspeakers, microphones etc. — a real push button system!

Emu Systems Limited,
1 East Street,
St Ives,
Huntingdon,
Cambridgeshire.
Telephone: 0480.61177

(2478 M)

Frequency counter

The model 8610B : 600 MHz has a frequency range of 10 Hz-600 MHz in three ranges with a 9 digit LED display with automatic decimal point and LED gate activity indicator. There is a front panel sensitivity control and two separate inputs for added versatility. Switch selectable gate times are: 0.1 second, 1 second and 10 seconds. Setability is ± 2 ppm and time base frequency is 10 MHz. Power requirement is 4.8 VDC-6.5 VDC (4 'C' cells) or there is line voltage via an AC adaptor. Weight is only 1.3 lbs without batteries.

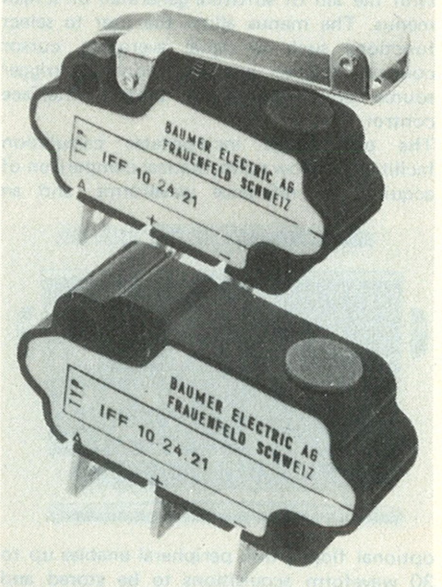
Stotron Ltd.,
Haywood Way,
Ivyhouse Lane,
Hastings,
Sussex.
Telephone: 0424.442160

(2476 M)

Inductive proximity switches

The new Baumer micro-switch-size inductive proximity switched are designed as plug-in replacements for conventional mechanical micro-switches. With no moving parts, there are obvious advantages in long life, less maintenance and greater reliability.

Switching capacity is 200 mA, with npn or pnp make or break output, and operating voltages 5 V to 30 V. Intrinsically safe versions are also available. Housing is robust plastic, in case size V3 with 6.3 x 0.8 mm 'Faston' connectors.



Britec Limited,
Unit 17, Bermondsey Trading Estate,
Rotherhithe New Road,
London SE16 3LL.
Telephone: 01.237.8081

(2475 M)

market

market

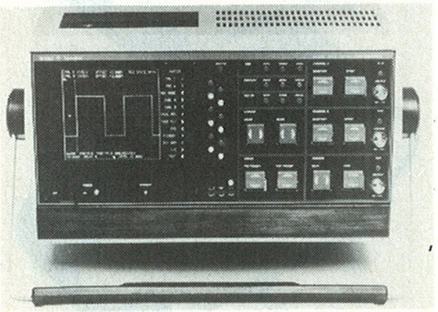
Digital oscilloscope

The 4500 digital oscilloscope from Gould Instruments Limited offers a 35 MHz bandwidth on each of its two channels, and is equally suited to high-speed recording of single-shot or repetitive signals and to systems use in automatic testing applications. The instrument's twin 100 MHz digitisers enable it to achieve an absolute voltage accuracy of ± 6.6% maximum over the recorded full-scale range, a resolution of 5.1 bits at 35 MHz, and a transient-response relative error of only ± 0.4% after 40 ns.

The 4500 incorporates an easy-to-use, oscilloscope-like control panel and display, plus an optional facility for computer control via an optional GPIB, RS-232C or fast access Unibus-compatible interface. A fast analogue interface is also included.

In benchtop recording applications, the 4500 can be used in the normal oscilloscope mode and by setting up the relevant parameters with the aid of software-generated on-screen menus. The menus allow the user to select functions such as signal averaging, cursor control, digital interface control, trigger source and filtering, or plotter interface control.

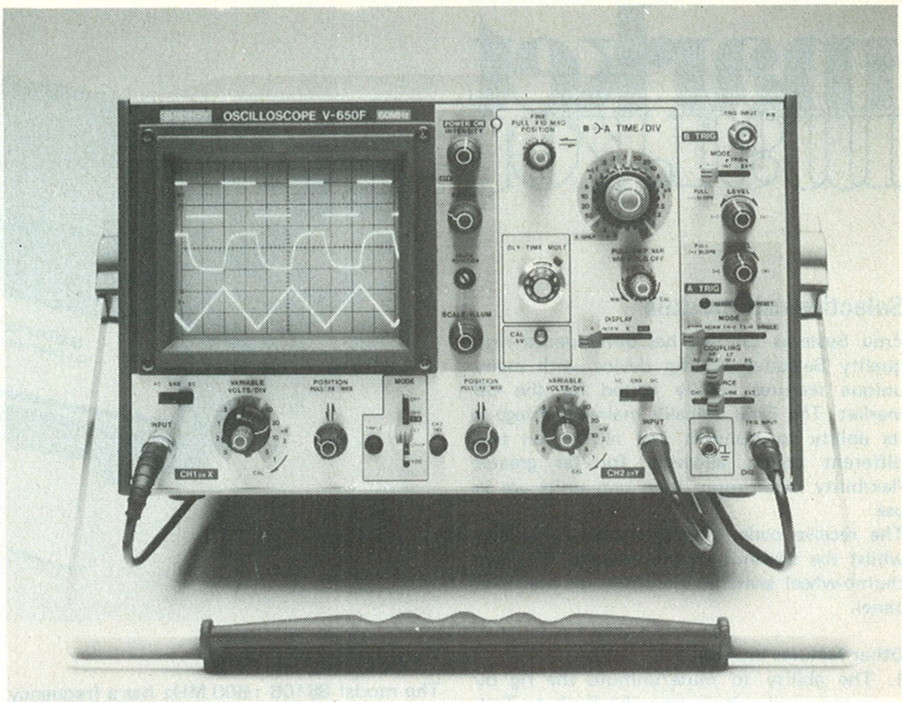
The oscilloscope incorporates calculation facilities to allow mathematical comparison of acquired or reference waveforms, and an optional floppy-disk peripheral enables up to 30 waveform acquisitions to be stored and later recalled to the display or to an external computer/controller.



The 4500 can be operated in a roll mode, like an oscillographic chart recorder, or in a scroll mode, so that test points can be compared sequentially. For waveform comparisons, it has a reference-memory capacity of 4 kbyte. It also has an acquisition-memory capacity of 1 kbyte per channel in the dual-channel mode, and 2 kbyte if a single channel is used. Up to four sets of instrument set-up parameters can be stored in a battery backed-up random-access memory. The display makes use of a 500-line vertical raster scan, which not only offers a higher-resolution display with more characters than the traditional flying-spot technique, but also aids the generation of 'menu' displays.

Gould Instruments Limited,
Roebuck Road,
Hainault,
Ilford,
Essex.
Telephone: 01.500.1000

(2443 M)



3 traces oscilloscope

The V-650F 60 MHz laboratory portable oscilloscope from Hitachi has the facility for displaying three traces simultaneously by way of it's versatile trigger-view function which can be used to access a Channel-3 input and display in either alternate or chopped modes. Other features include vertical sensitivity to 1 mV/division, dual timebases with calibrated delay multiplier and full B trigger control variable trigger hold-off and sweep speeds to 5 nsec/cm using the X10 magnifier. The 6½" rectangular CRT has a metal backed phosphor for increased brightness and an internal graticule to avoid parallax errors. Trace sharpness is particularly good.

A new and unusual feature is the Channel-1 output socket which enables a frequency counter, chart recorder or digital storage unit to be driven using the gain or attenuation of the internal Y amplifier.

Reltech Instruments,
Coach Mews,
St. Ives,
Huntingdon,
Cambs. PE17 4BN.
Telephone: 0480.63570

(2439 M)

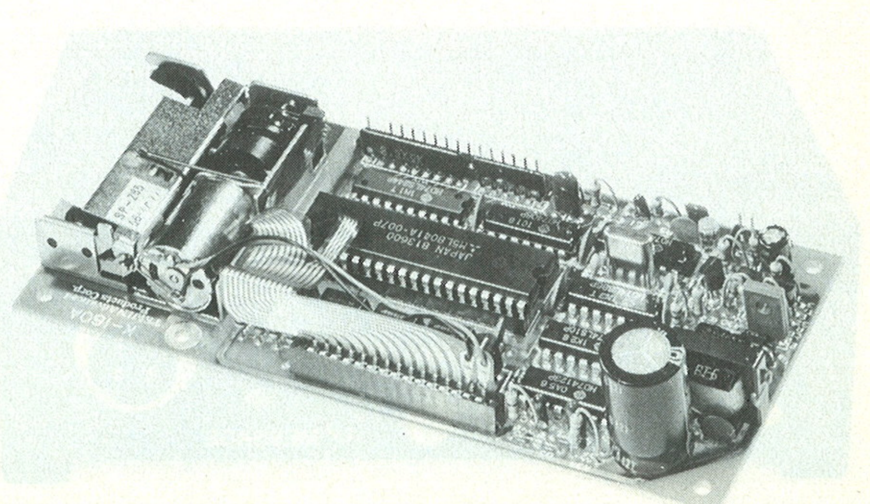
Miniature 5 V thermal printer

The K160 is a 16 column miniature thermal printer mounted on a printed circuit board from Roxburgh Printers. It consists of a print head, the SP 285, on a PCB together with the power supply, drive electronics and interface to a microprocessor bus.

A distinctive feature is that only a +5 Vdc supply is required as an inverter is used to generate the thermal elements' voltage. As the K160 also interfaces directly to an 8 bit parallel bus, incorporating it into a microprocessor system is extremely simple. ASCII data is sent to the K160's customised microprocessor which also controls all timing, drive and character generating functions of the print head. It also has programmable line feed and self test programs. The K160 uses 38 mm wide thermal paper and prints at 1.75 lines per second. The right two columns are offset by one column which can be useful for printing units or exponential powers.

Roxburgh Printers Ltd.,
22 Winchelsea Road,
Rye,
East Sussex.
Telephone: 07973.3777

(2442 M)



market

True RMS 4¾ digit multimeter

The newly introduced 1504 multimeter from Thurlby Electronics combines true RMS ac measurements with a 4¾ digit scale length. The instrument is designed for bench or field operation and has a high contrast Liquid Crystal Display with a full scale of ± 32,000 counts which gives it 60% greater resolution than 4½ digit units.

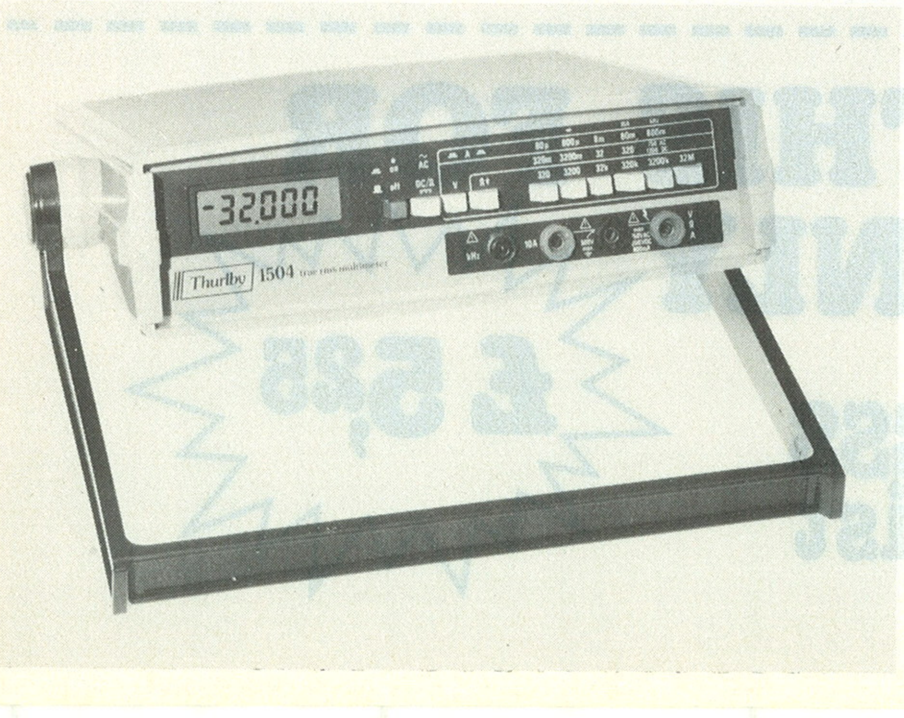
The basic accuracy is 0.05% guaranteed for 1 year and the 1504 can measure dc voltage up to ± 1200 volts, ac voltage up to 750 V, dc and ac current up to 10 amps, and resistance up to 32 MΩ. Sensitivity on the 320 mV dc range is 10 μV, and voltages up to ± 3.2 volts can be measured with an input impedance greater than 1,000 MΩ avoiding loading errors when measuring high impedance circuity. Maximum sensitivity on dc current is 1 nA, and on resistance is 0.01 Ω.

All ac measurements are True RMS responding and consequently give a correct reading of the power content of non-sinusoidal waveforms such as those found in thyristor switching circuits. The meter will accept a crest factor (peak to RMS ratio) of 5 at 10,000 counts.

The resistance ranges provide for high accuracy diode test measurements by virtue of their constant current excitation system, whilst the long scale length enables in-circuit resistance measurements to be made across semi-conductor junctions without losing accuracy. The 1504 also features a frequency measurement function which enables pulse waveforms up to 3.9999 MHz to be measured with an accuracy of 0.005% and a resolution of 100 Hz. All ranges and functions are protected against overload to a minimum voltage of 250 V rms. The meter is housed in a rugged ABS bench/portable case measuring 9 in x 9 in x 2½ in and weighing 2½ lbs. It can operate from ac line power or from internal batteries by virtue of its low power consumption. The 1504 is supplied complete with test leads and manual and costs £175 plus VAT within the UK.

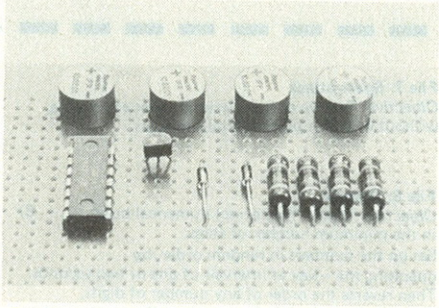
Thurlby Electronics Ltd.,
Coach Mews,
St. Ives,
Huntingdon,
Cambs,
PE17 4BN.
Telephone: 0480.63570

(2482 M)



PCB mounting inductive proximity sensors

Baumer Electric of Switzerland announce the IFR-1082 series of miniature proximity sensor which are ideal for multiple switching applications, and are small enough to be mounted in rows on a PCB: for example to detect the positions of various cams in a bank and for sequential switching. Models with minimum sensing distances 2 mm or 4 mm are available.



The small size, and hence close packing density, make the IFR 1082 series sensors very simple to mount and to design in, and prices are very much lower than conventional inductive proximity devices.

Britec Limited,
Unit 17,
Bermondsey Industrial Estate,
Rotherhithe New Road,
London SE16 3LL.
Telephone: 01.237.8081

(2479 M)

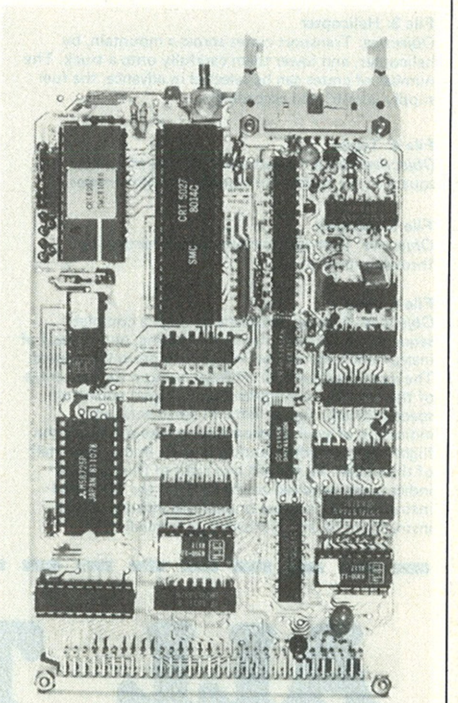
Memory mapped VDU card

A memory mapped VDU card is one of a range of Z80 single Eurocards available from Electronic Hobbies Ltd. The card is of the standard 100 x 160 mm (6½ x 4 in) size and is fully compatible with others in the series. It has a 2K RAM optimised for a 80 x 24 character display and is priced at £305 (plus P&P at £1.75 and VAT). Less sophisticated versions are available from £170.

A display of up to 8,000 characters or 256 x 256 graphic dots can be produced, configured by software from an optional screen memory of 1K to 8K bytes. Similarly text or tables may be generated with from 20 to 128 characters per line and up to 64 lines displayed.

Display size, character width and graphic modes are controlled by software which offers greater flexibility. The card has the advantage over some existing systems, ensuring a consistent display, by giving display generation optional priority, allowing the CPU to 'wait'. For other systems, circuit generation can result from attempted simultaneously access to screen memory by the CPU and the disply, thus enabling the CPU to take control and degrading the display quality.

The card can also operate in a system with 64K RAM, display memory accessed from the CPU may be configured to 'shadow' the existing system memory with display memory appearing at row and column addresses to the CPU, the necessary decoding to 'linear' addressing is then transparently handled by the card.



There are three graphic modes available, one giving a bit mapped display, each memory bit corresponding to a single dot on the screen; the second divides character cell into 8 blocks, using one bit of the data word to control each block; the final mode controls predetermined graphic shapes intended for line drawings, using 3 bits in each word.

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Objective: Shoot the aliens. The higher up the screen they are, the more points you gain. You have three launches; losing the third ends the game.

File 2: Flipper
Objective: Keep the ball in play for as long as possible. You have five balls for each game, as displayed at lower left.

File 3: Helicopter
Objective: Transport crates across a mountain, by helicopter, and lower them carefully onto a truck. The number of crates can be selected in advance; the fuel supply is restricted accordingly.

File 4: Teaser
Objective: Obtain a pattern consisting of a single square in the centre, surrounded by eight crosses.

File 5: Catapult
Objective: Destroy your opponent's fortress by throwing rocks at it.

File 6: Pilot
Objective: Pilot an aeroplane through a complete sequence of take-off, flight and landing, on the basis of instrument readings and instructions from the ground. The instruments are an artificial horizon (in the centre of the screen), an altimeter (upper right) and an air-speed indicator (upper left). Furthermore, an indication of your progress during take-off, along the flight path and when landing is given in the lower half of the screen. To the left and right of this, arrows indicate any required course changes (or 'OK') and instructions to increase or decrease altitude. These instructions must be followed up immediately.

File 7: Space attack
Objective: Survive as many attack waves as possible, without being hit by the various missiles.

File 8: Reverse
Objective: Obtain the correct numerical order (1 . . . 8) in the minimum number of steps.
Set up the numbers in random order, by operating the –key at intervals of one or two seconds. Then reverse the order of any number of digits, counting from the left, by operating the corresponding number key (2 . . . 8). The number of steps required is indicated at the end of the game.

File 9: Space hunt
Objective: Pass through several sectors of space. After eliminating all enemies in each sector, pass on to the next by moving off the right-hand edge of the screen.
Enemies can be knocked out by ramming, provided your shields are raised (even then it is not recommended unless there is a starbase nearby). Unshielded enemies can be shot with torpedoes. Shielded enemies can only be killed by means of a phaser attack, but this is expensive on energy.

File A: Basket-ball
Objective: Score by landing the 'ball' in the 'basket'. Total playing time: five minutes.
Players are moved horizontally by means of the joysticks. When a player is manoeuvered so that he appears facing forwards, vertical movement is also possible under joystick control (this corresponds to moving from one side of the field to the other).

File B: Bursting balloons
Objective: Destroy the balloons (or 'ceiling bricks', if you prefer), by bouncing the missile off them. You have five missiles per game. Scoring: green = 1 point, blue = 5 points, red = 10 points. The 'highest score of the day' is displayed at the lower edge of the screen. When the last balloon is hit, a comple new set appears immediately, so that quite high scores can be achieved.

File C: Für Elise
Objective: Add a touch of 'culture' to the computer era.

File D: Editor
Objective: This program consists of six independent routines that have proved useful when developing or modifying software.
3: Disassembler. Enter the Start Address of the program to be examined.

File E: Galgenspiel

File F: Hangman
These two files are German- and English-language versions of the same program. The objective is to guess a word that is selected at random from an extensive vocabulary.

File 1: Hangman word entry
Objective: This program is loaded immediately after file E or F, and is used to compile a new vocabulary for 'Hangman'.

General comments
Joystick calibration: where relevant, this is included in all programs. Note that it is essential that the joysticks are centered when the program is first started.
Sound effects: All programs have been modified to utilise any sound effects generator that is available:

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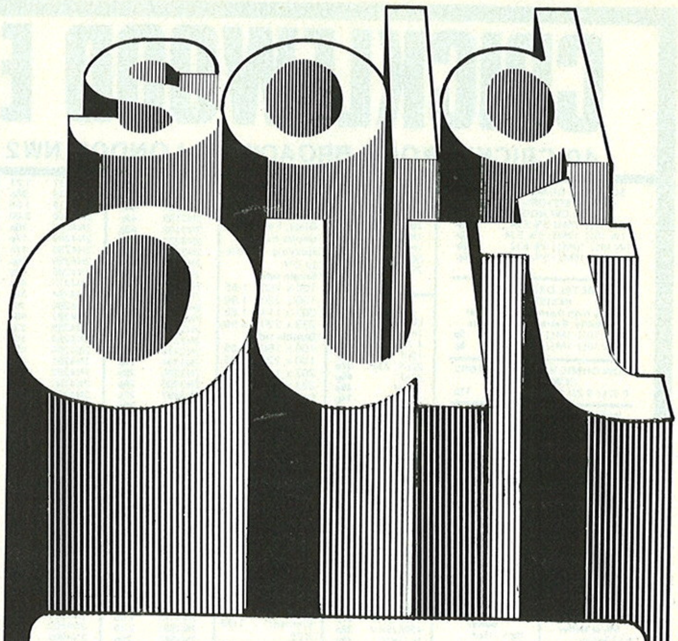

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2.2	350	30p
3.3	25	10p
3.3	40	11p
3.3	63	12p
4.7	16	8p
4.7	25	9p
4.7	40	11p
4.7	63	12p
4.7	100	14p
10	25	8p
10	40	12p
10	63	14p
10	100	16p
22	25	11p
22	40	14p
22	63	16p
22	100	21p
47	25	14p
47	40	17p
47	63	26p
47	100	28p
68	25	18p
68	63	25p
100	16	14p
100	25	16p
100	40	22p
100	63	25p
100	100	30p
220	10	16p
220	16	17p
220	25	22p
220	40	25p
220	63	30p
220	100	40p
330	16	19p
330	25	22p
330	63	38p
470	16	22p
470	25	28p
470	40	33p
470	63	43p
470	100	60p
1000	16	30p
1000	25	38p
1000	40	46p
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Beautiful Mini Radial Low Voltage

Matsushita only

uFd	V	
10	16	6p
22	10	6p
22	16	7p
47	10	7p
47	16	8p
100	10	9p
100	16	10p
220	10	11p
220	16	12p
470	10	17p
470	16	18p
1000	10	20p
1000	16	24p
2200	10	34p
2200	16	44p

PHOTO SENSITIVE PCB

1st Class Epoxy Glass. For better results than spraying. Expose to UV

Single sided	
100 × 160	1.55
100 × 220	1.90
203 × 114	1.85
233 × 220	3.99
Double sided	
100 × 160	1.65
100 × 220	2.15
203 × 114	2.21
233 × 220	4.55
Developer for above (do not use Sodium Hydroxide) 500 ml	2.50

DALO ETCH RESIST PEN

+ spare nib 90p

ANTEX SOLDERING IRONS

C240 (15W)	4.59
X25 (25W)	4.99
Iron stand	1.65
C240 Element	1.99
X25 Element	2.05
Bits C240	
No 2 (Small)	65p
No 3 (Med)	65p
No 6 (Lge)	65p
Bits X25	
No 50 (Small)	65p
No 51 (Med)	65p
No 52 (Lge)	65p

SOLDER

125gms

18 swg	2.95
22 swg	3.10

DIL SOCKETS

Pins	Lo-prof	W.Wp.
8	8 p	25 p
14	9 p	35 p
16	10 p	40 p
18	16 p	50 p
20	20 p	—
22	22 p	—
24	24 p	70 p
28	28 p	79 p
40	30 p	99 p

TRANSISTORS

Probably the largest retail variety in UK. If you don't see what you want please phone or write as this is not a full list

2N404	1.50
2N914	20p
2N916	39p
2N917	65p
2N918	33p
2N929	36p
2N929A	45p
2N930	20p
2N930A	30p
2N1131	24p
2N1132	25p
2N1302	45p
2N1303	65p
2N1304	60p
2N1306	65p
2N1308	65p
2N3170	58p
2N1420	66p
2N1483	2.95
2N1485	3.47
2N1507	42p
2N1524	58p
2N1702	3.20
2N1711	35p
2N1889	50p
2N1890	50p
2N1893	30p
2N1974	1.50
2N2060	7.14
2N2102	39p
2N2217	39p
2N2218	33p
2N2218A	25p
2N2219	27p
2N2219A	28p
2N2220	22p
2N2221	22p
2N2221A	23p
2N2222	24p
2N2222A	25p
2N2223	2.60
2N2223A	4.15
2N2303	39p
2N2368	25p
2N2369	19p
2N2369	18p
2N2405	88p
2N2410	1.15
2N2411	3.60
2N2412	80p
2N2477	95p
2N2483	25p
2N2484	26p
2N2491	8.00
2N2646	45p
2N2647	98p
2N2714	12p
2N2848	60p
2N2875	2.20
2N2890	1.10
2N2891	2.28
2N2892	3.00
2N2904A	27p
2N2905	28p
2N2905A	29p
2N2906	25p
2N2906A	30p
2N2907	25p
2N2907A	26p
2N2920	3.47
2N2923	25p
2N2924	15p
2N2925	15p
2N2926	10p
2N3010	75p
2N3011	25p
2N3019	50p
2N3053	27p
2N3054	56p

2N3055CSF	60p
2N3055RCA	80p
2N3107	46p
2N3108	42p
2N3109	48p
2N3232	1.50
2N3250	36p
2N3251	36p
2N3300	60p
2N3301	68p
2N3302	80p
2N3390	38p
2N3391	30p
2N3391A	34p
2N3392	27p
2N2393	24p
2N3394	20p
2N3395	26p
2N3396	26p
2N3397	27p
2N3402	35p
2N3403	50p
2N3404	50p
2N3405	50p
2N3416	24p
2N3417	23p
2N3420	2.50
2N3439	98p
2N3440	80p
2N3441	1.25
2N3442	1.35
2N3442MOT	2.40
2N3444	1.70
2N3445	4.80
2N3446	6.09
2N3447	5.72
2N3448	6.56
2N3468	1.00
2N3512	1.06
2N3553	2.30
2N3563	20p
2N3564	25p
2N3565	20p
2N3566	50p
2N3567	55p
2N3568	50p
2N3569	50p
2N3570	2.54
2N3571	2.19
2N3572	2.06
2N3584	2.76
2N3585	2.99
2N3605	36p
2N3606	28p
2N3607	28p
2N3632	9.88
2N3638	35p
2N3638A	37p
2N3639	36p
2N3641	39p
2N3642	25p
2N3643	15p
2N3644	28p
2N3645	33p
2N3646	28p
2N3662	15p
2N3663	16p
2N3691	18p
2N3692	20p
2N3693	25p
2N3694	30p
2N3702	10p
2N3703	10p
2N3704	10p
2N3705	10p
2N3706	10p
2N3707	10p
2N3708	10p
2N3709	10p
2N3710	10p
2N3711	10p
2N3712	2.00
2N3713	1.38
2N3714	2.98
2N3715	3.31
2N3716	3.60
2N3724	75p
2N3725	85p
2N3730	4.65
2N3732	2.88
2N3734	1.30
2N3725	2.45
2N3738	2.00
2N3740	2.38
2N3741	2.76
2N3766	2.90
2N3767	3.19
2N3771	1.75
2N3772	1.83
2N3773	2.06
2N3779	1.70
2N3789	3.27
2N3790	2.73
2N3791	2.47
2N3792	2.68
2N3749	25p
2N3819	21p
2N3820	38p
2N3821	1.84
2N3822	90p
2N3823	45p
2N3824	1.70
2N3826	78p
2N3827	78p
2N3854	44p
2N3855	30p
2N3855A	40p
2N3856	45p
2N3858	31p
2N3858A	37p
2N3859A	31p
2N3860	31p
2N3866	90p
2N3877A	35p
2N3900	25p
2N3901	30p
2N3902	6.65
2N3903	15p
2N3904	15p
2N3905	15p
2N3906	15p
2N3945	85p
2N3962	30p
2N3964	1.42
2N4030	66p
2N4031	55p
2N4032	65p
2N4036	58p
2N4037	43p
2N4058	10p
2N4059	17p
2N4060	12p
2N4061	10p
2N4062	10p
2N4064	1.15
2N4069	1.00
2N4074	75p
2N4092	98p
2N4093	1.20
2N4121	45p
2N4122	45p
2N4123	21p
2N4124	35p
2N4125	37p
2N4126	27p
2N4220	75p
2N4221	95p
2N4222	97p
2N4223	97p
2N4224	98p
2N4234	45p
2N4236	45p

2N4237	1.21
2N4238	95p
2N4239	1.00
2N4240	3.00
2N4248	15p
2N4249	17p
2N4250	17p
2N4258	75p
2N4266	45p
2N4275	48p
2N4284	32p
2N4285	35p
2N4287	45p
2N4288	22p
2N4289	15p
2N4290	45p
2N4291	45p
2N4292	45p
2N4294	45p
2N4297	2.50
2N4302	39p
2N4303	40p
2N4304	41p
2N4314	60p
2N4342	68p
2N4347	2.26
2N4351	1.16
2N4400	15p
2N4401	27p
2N4402	30p
2N4403	30p
2N4409	36p
2N4410	42p
2N4427	79p
2N4440	12.58
2N4870	80p
2N4871	55p
2N4888	92p
2N4898	1.29
2N4901	1.69
2N4902	3.52
2N4903	3.24
2N4904	2.75
2N4905	3.25
2N4906	3.42
2N4907	3.20
2N4908	3.70
2N4909	2.90
2N4910	1.95
2N4913	2.59
2N4914	2.69
2N4915	2.95
2N4916	48p
2N4917	47p
2N4918	95p
2N4919	1.28
2N4920	1.34
2N4921	55p
2N4922	69p
2N4923	99p
2N4924	92p
2N4926	95p
2N4927	95p
2N4928	1.59
2N4964	27p
2N4965	25p
2N4966	25p
2N4967	25p
2N4968	25p
2N4969	31p
2N5010	8.50
2N5011	9.37
2N5030	44p
2N5033	48p
2N5036	1.60
2N5036	1.95
2N5039	3.90
2N5086	36p
2N5087	39p
2N5088	37p
2N5089	37p
2N5126	48p
2N5217	38p
2N5128	38p
2N5129	30p
2N5130	37p
2N5131	22p
2N5133	22p
2N5135	38p
2N5136	38p
2N5137	23p
2N5138	18p
2N5139	48p
2N5140	25p
2N5141	25p
2N5143	25p
2N5172	15p
2N5175	58p
2N5179	39p
2N5180	43p
2N5183	1.00
2N5184	1.10
2N5188	1.15
2N5189	1.00
2N5190	68p
2N5191	70p
2N5193	90p
2N5194	79p
2N5209	24p
2N5210	25p
2N5219	25p
2N5220	15p
2N5221	25p
2N5222	28p
2N5223	15p
2N5224	38p
2N5225	25p
2N5226	25p
2N5227	25p
2N5232	30p
2N5232A	32p
2N5245	37p
2N5246	40p
2N5247	45p
2N5248	46p
2N5249	48p
2N5266	2.88
2N5293	98p
2N5294	1.28
2N5295	1.37
2N5296	1.28
2N5298	1.37
2N5302	3.20
2N5303	3.80
2N5305	25p
2N5306	37p
2N5307	40p
2N5308	25p
2N5354	19p
2N5355	19p
2N5358	73p
2N5366	25p
2N5367	28p
2N5401	35p
2N5415	1.10
2N5416	1.54
2N5447	16p
2N5448	19p
2N5449	21p
2N5450	23p
2N5451	25p
2N5457	29p
2N5458	29p
2N5459	29p
2N5460	72p
2N5461	60p
2N5462	80p
2N5484	40p
2N5485	29p
2N5490	1.37
2N5492	1.56
2N5494	1.37
2N5496	1.59

2N5543	5.00
2N5551	37p
2N5640	45p
2N5654	35p
2N5786	80p
2N5813	23p
2N6027	30p
2N6030	6.60
2N6082	11.99
2N6099	1.20
2N6101	1.30
2N6109	1.15
2N6111	1.00
2N6121	54p
2N6122	56p
2N6123	59p
2N6124	56p
2N6125	59p
2N6126	71p
2N6129	79p
2N6130	93p
2N6131	98p
2N6132	83p
2N6133	1.14
2N6134	1.36
2N6253	1.45
2N6254	1.55
2SC1306	95p
2SC1444	2.50
2SC2078	1.70
2SJ49	3.98
2SJ82	3.98
2SK134	3.98
2SK226	3.98
3N139	3.30
3N140	2.37
3N143	2.85
3N152	3.00
3N153	2.47
3N154	2.56
3N200	6.93
3N201	2.98
40250	95p
40251	2.77
40254	2.75
40264	2.63
40280	2.00
40290	2.00
40309	1.80
40311	97p
40312	1.64
40313	1.89
40315	1.94
40316	95p
40324	1.86
40325	2.46
40326	1.98
40346	1.30
40347	89p
40348	1.95
40360	60p
40361	67p
40362	67p
40363	2.22
40364	2.90
40372	1.80
40373	2.60
40374	2.84
40389	1.24
40390	2.72
40392	1.20
40394	1.10
40394	1.70
40406	1.39
40407	75p
40408	1.59
40410	1.80
40411	2.85
40412	90p
40422	2.95
40467A	1.29
40513	1.75
40537	96p
49543	1.60
40594	99p
40595	99p
40600	2.58
40601	2.36
40602	1.68
40603	1.09
40604	1.85
40608	2.44
40622	1.45
40625	1.60
40626	3.20
40631	1.90
40631	2.12
40635	1.35
40637	2.00
40643	1.80
40673	83p
40822	1.80
40871	89p
40872	89p
AC125	35p
AC126	25p
AC127	25p
AC128	25p
AC132	39p
AC151	51p
AC152	45p
AC153	55p
AC153K	64p
AC176	27p
AC176K	37p
AC187	25p
AC187K	28p
AC188	25p
AC188K	40p
ACY17	70p
ACY18	90p
ACY20	75p
ACY21	75p
ACY22	75p
ACY28	75p
ACY44	98p
AD136	7.90
AD145	1.65
AD149	79p
AD150	1.31
AD161	39p
AD162	39p
AF106	75p
AF109	75p
AF114	65p
AF117	70p
AF118	89p
AF124	72p
AF125	72p
AF126	72p
AF139	53p
AF170	88p
AF172	88p
AF178	88p
AF200	65p
AF201	75p
AF239	1.24
AF240	1.00
AF279B	75p
AF279G	75p
AL102	3.49
AU110	2.20
AU113	2.30
BC107	10p
BC107A	12p
BC107B	12p
BC108	10p
BC108A	12p
BC108B	12p
BC108C	14p
BC109	10p
BC109B	12p
BC109C	12p

BC113	30p
BC114	19p
BC115	22p
BC116	32p
BC116A	37p
BC117	19p
BC118	19p
BC119	38p
BC121	82p
BC123	82p
BC125	37p
BC132	39p
BC134	36p
BC135	45p
BC136	45p
BC137	39p
BC138	55p
BC140	29p
BC141	37p
BC142	29p
BC143	34p
BC147	10p
BC147A	10p
BC147B	10p
BC147C	20p
BC148	10p
BC148A	12p
BC148B	13p
BC148C	13p
BC149	10p
BC149B	12p
BC149C	13p
BC152	35p
BC153	23p
BC154	27p
BC157	11p
BC157A	12p
BC157B	13p
BC158	10p
BC158A	12p
BC158B	13p
BC159	11p
BC159A	12p
BC159B	13p
BC159C	18p
BC160	42p
BC161	48p
BC167	10p
BC167A	10p
BC167B	13p
BC168	10p
BC168B	10p
BC168C	10p
BC169	10p
BC169B	10p
BC169C	10p
BC170	15p
BC170A	17p
BC170B	17p
BC170C	18p
BC171	12p
BC171A	15p
BC171B	15p
BC172	12p
BC172A	15p
BC172B	15p
BC172C	16p
BC173	11p
BC173B	16p
BC173C	16p
BC174	21p
BC174A	24p
BC174B	24p
BC175	75p
BC177	16p
BC177A	25p
BC177B	26p
BC178	16p
BC178A	24p
BC178B	25p
BC179	20p
BC179A	25p
BC179B	25p
BC179C	27p
BC182	10p
BC182A	12p
BC182B	13p
BC182L	10p
BC182LA	13p
BC182LB	14p
BC183	10p
BC183A	11p
BC183B	12p
BC183C	13p
BC183L	10p
BC183LA	13p
BC183LB	13p
BC183LC	14p
BC184	10p
BC184B	12p
BC184C	13p
BC184L	10p
BC184LB	13p
BC184LC	14p
BC196	24p
BC187	24p
BC204	29p
BC205	29p
BC206	29p
BC207	29p
BC208	29p
BC209	29p
BC212	10p
BC212A	12p
BC212B	13p
BC212L	10p
BC212LA	13p
BC212LB	14p
BC213	10p
BC213A	11p
BC213B	12p
BC213C	13p
BC213L	10p
BC213LB	13p
BC213LC	14p
BC214	10p
BC214B	12p
BC214C	13p
BC214L	10p
BC214LB	13p
BC214LC	14p
BC237	14p
BC237A	16p
BC237B	17p
BC237C	18p
BC238	14p
BC238A	15p
BC238B	16p
BC238C	17p
BC239	15p
BC239A	16p
BC239B	17p
BC239C	18p
BC250	22p
BC250A	23p
BC250B	24p
BC250C	25p
BC251	25p
BC251A	26p
BC251B	27p
BC251C	28p
BC252	22p
BC252B	23p
BC252C	24p
BC253	22p
BC253B	23p
BC253C	24p
BC256	25p
BC256A	26p
BC256B	27p
BC257	26p
BC257A	27p
BC258	24p

BC258A	25p
BC258B	26p
BC259	25p
BC259B	26p
BC259C	27p
BC260	30p
BC260B	32p
BC260C	33p
BC261	33p
BC261A	34p
BC261B	35p
BC261C	36p
BC262	31p
BC262A	32p
BC262B	33p
BC262C	34p
BC263	30p
BC263B	31p
BC263C	32p
BC264	40p
BC264B	42p
BC266	35p
BC266A	36p
BC266B	37p
BC300	45p
BC301	44p
BC302	43p
BC303	47p
BC304	46p
BC307	13p
BC307A	14p
BC307B	15p
BC308	12p
BC308A	13p
BC308B	14p
BC309	14p
BC309A	15p
BC309B	16p
BC309C	17p
BC317	15p
BC318	15p
BC320	25p
BC321	25p
BC327	14p
BC328	14p
BC337	15p
BC338	15p
BC347	20p
BC350	20p
BC382	30p
BC382L	30p
BC383	30p
BC383L	30p
BC384	30p
BC384L	30p
BC407	30p
BC408	24p
BC409	30p
BC413	25p
BC414	25p
BC415	30p
BC416	30p
BC418	30p
BC440	32p
BC441	33p
BC460	32p
BC461	33p
BC478	29p
BC479	30p
BC516	40p
BC517	40p
BC547	13p
BC547A	14p
BC547B	14p
BC548	12p
BC548A	13p
BC548B	14p
BC548C	15p
BC549	13p
BC549B	14p
BC549C	15p
BC550	30p
BC550C	33p
BC557	15p
BC557A	16p
BC557B	16p
BC558	14p
BC558A	15p
BC558B	16p
BC559	15p
BC559B	16p
BC559C	17p
BC560	32p
BC560C	34p
BC727	44p
BC737	44p
BCW32R	60p
BCY30	1.15
BCY30A	1.30
BCY31	1.15
BCY31A	1.30
BCY32	1.15
BCY32A	1.30
BCY33	80p
BCY33A	1.00
BCY34	80p
BCY34A	80p
BCY54	1.91
BCY58	32p
BCY59	33p
BCY66	1.80
BCY67	2.00
BCY70	16p
BCY71	16p
BCY72	19p
BCY77	34p
BCY78	22p
BCY79	22p
BCY87	6.60
BCY88	4.90
BCY89	4.10
BCZ10	4.60
BCZ11	4.60
BD115	58p
BD116	2.50
BD121	2.25
BD124	1.50
BD131	44p
BD132	44p
BD135	40p
BD136	40p
BD137	42p
BD138	39p
BD139	39p
BD140	39p
BD142	2.40
BD153	1.25
BD155	1.20
BD157	54p
BD158	55p
BD160	3.80
BD181	1.75
BD182	2.50
BD183	2.70
BD187	1.09
BD201	1.30
BD202	1.39
BD204	1.44
BD220	1.00
BD221	95p
BD223	1.00
BD224	95p
BD232	1.11
BD233	70p
BD234	72p
BD237	98p
BD238	98p
BD239A	57p
BD239C	64p
BD240A	59p
BD240C	73p
BD241A	61p
BD241C	67p

BD242A	65p
BD242C	70p
BD243A	72p
BD143C	85p
BD244A	82p
BC244C	1.00
BD245A	1.14
BD245C	1.30
BD246A	1.20
BD246C	1.50
BC249A	2.00
BD249C	2.31
BD250A	2.11
BD250C	2.46
BD433	79p
BD434	55p
BD435	81p
BD436	81p
BD437	88p
BD438	88p
BD439	90p
BD440	91p
BD441	91p
BD442	93p
BD529	1.20
BD530	1.30
BD535	75p
BD536	75p
BD537	80p
BD538	80p
BD539	80p
BD539C	1.10
BD540	85p
BD540C	1.20
BD675	72p
BD676	77p
BD677	78p
BD678	83p
BD711	1.32
BD712	1.32
BDX14	1.30
BDX18	1.59
BDX32	3.47
BDY10	2.00
BDY11	2.50
BDY17	2.89
BDY23	3.40
BDY25	3.75
BDY38	1.74
BDY54	1.70
BDY55	1.75
BDY56	1.80
BDY57	5.25
BDY58	6.15
BDY60	1.60
BDY61	2.80
BDY62	2.34
BDY92	3.75
BF115	35p
BF119	1.00
BF121	75p
BF123	70p
BF127	80p
BF153	39p
BF154	25p
BF157	58p
BF158	25p
BF159	58p
BF160	55p
BF161	58p
BF163	50p
BF166	57p
BF167	29p
BF170	79p
BF173	25p
BF174	77p
BF177	25p
BF178	30p
BF179	35p
BF180	35p
BF181	36p
BF182	36p
BF183	38p
BF184	36p
BF185	37p
BF194	12p
BF195	12p
BF196	12p
BF197	12p
BF198	15p
BF199	15p
BF200	1.49
BF224J	32p
BF225J	35p
BF240	38p
BF241	38p
BF244A	35p
BF244B	39p
BF245A	
BF245B	51p
BF246	52p
BF246A	
BF246B	51p
BF247A	54p
BF247B	55p
BF254	39p
BF255	42p
BF256A	35p
BF256B	45p
BF256C	62p
BF257	30p
BF258	32p
BF259	35p
BF262	80p
BF263	90p
BF270	65p
BF271	68p
BF273	40p
BF274	40p
BF324	38p
BF336	36p
BF337	28p
BF338	48p
BF355	60p
BF362	85p
BF363	85p
BF457	46p
BF458	56p
BF459	62p
BF469	86p
BF470	86p
BFR39	25p
BFR40	25p
BFR41	25p
BFR79	25p
BFR80	25p
BFR81	25p
BFR90	2.11
BFS28	2.95
BFS61	1.00
BFS98	1.10
BFT19	1.65
BFT19B	1.88
BFT66	2.48
BFW10	1.48
BFW10	1.48
BFW11	1.48
BFW43	2.47
BFW59	1.06
BFW87	1.53
BFW90	1.53
BFX12	1.00
BFX13	91p
BFX19	50p
BFX20	80p
BFX29	26p
BFX30	27p
BFX34	1.00
BFX37	70p
BFX43	70p
BFX68	1.00
BFX84	27p
BFX85	28p

BFX86	28p
BFX87	25p
BFX88	26p
BFX89	1.75
BFY18	48p
BFY19	1.10
BFY37	1.20
BFY39	50p
BFY41	1.16
BFY50	23p
BFY51	23p
BFY52	23p
BFY53	31p
BFY56	31p
BFY56A	68p
BFY75	75p
BFY76	50p
BFY77	80p
BFY78	80p
BFY90	79p
BSV81	1.87
BSW41	95p
BSW67	1.00
BSW70	1.00
BSX19	24p
BSX20	24p
BSX21	40p
BSX26	34p
BSX27	78p
BSX28	66p
BSX29	34p
BSX39	80p
BSX60	75p
BSX61	80p
BSX76	50p
BSX77	55p
BSY24	77p
BSY25	1.00
BSY26	35p
BSY29	70p
BSY39	47p
BSY54	40p
BSY65	58p
BSY95A	25p
BU104	2.22
BU105	1.70
BU109	3.29
BU126	1.47
BU204	2.25
BU205	1.75
BU206	1.89
BU208	1.98
BU326S	2.35
BU406	1.45
BU407	1.45
BU408	1.35
BU409	1.25
BU500	2.95
BUV20	11.00
BUV21	10.90
BUV23	13.60
BUV24	12.10
BUV25	15.00
BUX20	17.00
BUY18S	3.95
J300	48p
J310	53p
MA8001	45p
MA8002	62p
MA8003	39p
MD7000	2.60
ME0401	25p
ME0402	30p
ME0404	25p
ME0411	35p
ME0412	35p
ME0413	35p
ME0414	48p
ME0461	45p
ME0462	45p
ME1001	45p
ME1002	45p
ME1075	45p
ME1100	45p
ME1120	48p
ME3002	25p
ME4001	45p
ME4002	45p
ME4003	45p
ME4101	25p
ME4101	25p
ME4103	25p
ME4104	25p
ME6001	25p
ME6002	25p
ME6003	25p
ME6101	29p
ME6102	28p
ME8001	47p
ME8002	62p
ME8003	50p
ME9001	56p
ME9002	56p
MFE3004	2.36
MJ400	2.98
MJ420	2.26
MJ430	2.98
MJ440	
MJ481	1.69
MJ491	1.72
MJ802	3.99
MJ900	2.90
MJ901	3.10
MJ1000	2.50
MJ1001	3.00
MJ1800	3.60
MJ2500	2.19
MJ2501	2.25
MJ2955	1.00
MJ3000	2.19
MJ3001	2.25
MJ3701	2.55
MJ4502	3.99
MJE340	53p
MJE370	97p
MJE371	99p
MJE520	92p
MJE521	94p
MJE1090	3.65
MJE1100	3.65
MJE2901	3.65
MJE2955	99p
MJE3055	69p
MP8111	1.00
MP8112	1.39
MP8121	1.35
MP8122	1.40
MP8123	1.16
MP8512	1.59
MPF102	39p
MPF103	29p
MPF104	29p
MPF105	29p
MPF112	59p
MPF121	1.69
MPS3638	27p
MPS3640	40p
MPS4356	60p
MPS6517	47p
MPS6518	47p
MPS6530	37p
MPS6560	32p
MPS6562	32p
MPSA05	23p
MPSA06	25p
MPSA10	28p
MPSA12	29p
MPSA13	48p
MPSA14	46p
MPSA16	30p
MPSA18	65p
MPSA20	48p
MPSA18	65p

MPSA42	49p
MPSA43	49p
MPSA55	28p
MPSA56	30p
MPSA65	40p
MPSA66	47p
MPSA70	45p
MPSA92	39p
MPSA93	39p
MPSL01	42p
MPSL51	48p
MPSU01	84p
MPSU04	1.32
MPSU05	55p
MPSU06	56p
MPSU07	75p
MPSU51	88p
MPSU55	58p
MPSU56	59p
MPSU57	1.20
MRF421	poa
MRF453	poa
MRF454	poa
MRF475	7.55
MRF477	poa
MRF479	poa
MRF604	poa
NKT124	63p
NKT125	49p
NKT126	47p
NKT128	42p
NKT129	40p
NKT135	40p
NKT137	42p
NKT210	42p
NKT215	40p
NKT216	65p
NKT218	44p
NKT219	40p
NKT224	40p
NKT225	40p
NKT229	40p
NKT238	46p
NKT239	44p
NKT240	42p
NKT241	40p
NKT242	40p
NKT243	86p
NKT243	86p
NKT244	40p
NKT254	40p
NKT261	40p
NKT262	40p
NKT271	40p
NKT272	40p
NKT275	40p
NKT281	47p
NKT404	2.68
NKT405	2.80
NKT406	2.50
NKT453	2.40
NKT603F	56p
NKT613F	55p
NKT674F	55p
NKT677F	55p
NKT713	47p
NKT717	52p
NKT734	55p
NKT736	58p
NKT773	40p
NKT781	43p
NKT12329	50p
NKT12429	57p
NKT13329	50p
NKT13429	54p
NKT16229	59p
NKT20329	38p
OC20	2.30
OC22	2.00
OC23	2.00
OC25	2.50
OC28	1.70
OC29	2.35
OC35	2.35
OC41	80p
OC43	70p
OC44	82p
OC70	50p
OC71	50p
OC72	50p
OC82	50p
OC82D	70p
OC83	75p
P346A	58p
R2008B	2.14
R2010B	1.88
SC107	27p
SC108	27p
SC109	27p
TIP29A	32p
TIP29C	38p
TIP30A	35p
TIP30C	38p
TIP31A	38p
TIP31C	39p
TIP32A	38p
TIP32C	42p
TIP33A	65p
TIP33C	78p
TIP34A	74p
TIP34C	88p
TIP35A	1.09
TIP35C	1.28
TIP36A	1.29
TIP36C	1.39
TIP41A	49p
TIP41C	55p
TIP42A	55p
TIP42C	65p
TIP49	1.20
TIP50	1.40
TIP53	1.57
TIP54	1.59
TIP110	74p
TIP112	90p
TIP115	81p
TIP117	96p
TIP120	69p
TIP122	73p
TIP125	1.20
TIP127	1.27
TIP130	1.50
TIP132	1.60
TIP135	1.60
TIP137	1.80
TIP140	1.04
TIP142	1.04
TIP145	1.19
TIP147	1.19
TIP2955	77p
TIP3055	70p
TIS37	62p
TIS43	40p
TIS45	66p
TIS46	66p
TIS47	49p
TIS48	65p
TIS49	66p
TIS50	60p
TIS51	65p
TIS52	70p
TIS53	97p
TIS54	85p
TIS55	66p
TIS58	92p

CRICKLEWOOD-STOCKING PARTS OTHER STORES CANNOT REACH!

Items not fully covered on this list include: **OPTO:** 7 seg LEDs, LCDs, bezelled LEDs, Lamps, Lampholders. **FUSES:** 20 mm, 1¼ inch, slow or quick blow, Fuseholders. **CONNECTORS:** DIL, DIN, Phono, 1 mm, 2 mm, 4 mm, Bulgin, USA, I.E.C. **KNOBS:** Plastic, Aluminium, Anodised, Collet, Pointer. **SWITCHES:** Toggle, Biased, Rocker, Rotary, Slide, DIL, Push. **METERS:** LCD, Analogue, Test and Panel. **TOOLS:** Pliers, Cutters, Strippers, Trimmers, Cable Cutters. And much, much more ....
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TIS60	42p
TIS62	44p
TIS64	67p
TIS87	60p
TIS88A	62p
TIS90	28p
TIS91	30p
TIS92	30p
TIS93	54p
VN10KM	60p
VN46AF	84p
VN66AF	85p
ZTX107	10p
ZTX108	10p
ZTX109	10p
ZTX300	13p
ZTX301	15p
ZTX302	15p
ZTX303	23p
ZTX304	15p
ZTX310	35p
ZTX311	32p
ZTX312	35p
ZTX313	36p
ZTX314	24p
ZTX320	35p
ZTX330	35p
ZTX341	28p
ZTX500	14p
ZTX501	14p
ZTX502	14p
ZTX503	17p
ZTX504	24p
ZTX510	34p
ZTX530	24p
ZTX531	25p

DIACS

BR100	40p
ST2	25p

THYRISTORS
Sensitive Gate
Small Signal

2N5060	30p
2N5061	32p
2N5062	35p
2N5063	37p
2N5064	40p
BR101	75p
BRY39	60p
BRY55-100	60p
BRY55-300	67p
BRY56	50p
TIC44	35p
TIC47	50p

4, 8 & 12 Amps
Texas TO220
Suffix: A = 100V
B = 200V
C = 300V
D = 400V
M = 600V

4A	TIC106A	46p
	TIC106B	47p
	TIC106C	48p
	TIC106D	59p
	TIC106M	68p
8A	TIC116A	66p
	TIC116B	68p
	TIC116C	71p
	TIC116D	73p
	TIC116M	80p
12A	TIC126A	72p
	TIC126B	72p
	TIC126C	73p
	TIC126D	77p
	TIC126M	95p

SIEMENS THRISTORS
1.2 amp plastic

Bst B0106 (100V)	60p
Bst B0113 (200V)	70p
Bst B0146 (700V)	1.12

4.7 amp plastic

Bst B0206 (100V)	80p
Bst B0213 (200V)	1.10
Bst B0246 (700V)	2.00

TV Thyristors

2N4444	1.80
BT101-500R	1.40
BT106	1.50
BT116 Use TIC116M	
BT119	1.70
BT120	1.50
BT121	1.30

TRIACS
Texas 400V
TO220 Case

TIC206D(4A)	66p
TIC225D(6A)	74p
TIC226D(8A)	88p
TIC236D(12A)	1.16
TIC246D(16A)	1.22
TIC253D(20A)	1.90
TIC263D(25A)	2.11

Other Triacs

2N5756 (TO5)	1.44
2N6155 (TO127)	3.39
40432 (Quadrac)	2.23
40486 (TO5)	1.65
40512	2.70
40576 (TO66)	3.33
40842	1.92

DIODES

1N34A	30p
1N821	70p
1N823	92p
1N914	4p
1N916	6p
1N1190	1.47
1N1192	1.75
1N1194	1.65
1N1194A	1.80
1N1196A	2.41
1N1198A	2.65
1N1201A	97p
1N1204A	1.00
1N1206	1.20
1N3063	36p
1N3065	48p
1N3492	1.85

1N3493	2.20
1N3493R	2.20
1N3602	36p
1N3604	45p
1N3766	3.00
1N3768	4.50
1N3768R	4.50
1N4001	4p
1N4002	4½p
1N4003	5p
1N4004	5½p
1N4005	6p
1N4006	6½p
1N4007	7p
1N4009	20p
1N4148	6p
1N4150	18p
1N4448	22p
1N4517	22p
1N5172	30p
1N5176	94p
1N5400	12p
1N5401	13p
1N5492	14p
1N5403	15p
1N5404	16p
1N5405	17p
1N5406	18p
1N5407	19p
1N5408	20p
1N5024	52p
1N5625	60p
1N5626	62p
1N5627	68p
1S44	10p
1S131	40p
1S134	56p
1S421	1.00
1S421R	1.00
1S940	10p
1S941	11p
1S961	22p
AA119	28p
AA129	57p
AA144	25p
AAY30	44p
AAY33	46p
AAZ17	27p
BA100	22p
BA102	25p
BA115	25p
BA133	40p
BA138	30p
BA142	20p
BA144	15p
BA155	15p
BA156	38p
BA182	40p
BA201	18p
BA202	26p
BA316	25p
BA317	25p
BA318	30p
BAV10	16p
BAV19	15p
BAV20	15p
BAV49	15p
BAX13	10p
BAX16	11p
BAY38	20p
BAY44	15p
BAY93	10p
BB103B	70p
BB103G	70p
BB104B	80p
BB104G	80p
BB105	52p
BB105A	57p
BB105B	58p
BB109G	65p
BY126	20p
BY127	22p
BY134	52p
BY182	1.26
BY188A	65p
BY206	36p
BY207	36p
BY223	1.56
BY297	48p
BY299	55p
BYW11-800	1.40
BYW11-1000	2.00
BYW12-100	1.30
BYW12-200	1.40
BYW12-400	2.00
BYX10	36p
BYX50-200R	2.00
BYX55-350	62p
BYX71-350	1.10
BYX71-600	1.52
ITT33	15p
ITT44	10p
ITT921	10p
ITT923	15p
ITT2002	27p
MZ2361	1.80
OA10	70p
OA47	20p
OA90	10p
OA91	10p
OA95	20p
OA200	20p
OA202	20p
RAS508AF	75p
SPD9000	75p
SPD9002	95p

2 amp type
Square with hole

S01 (100)	37p
S02 (200)	40p
S04 (400)	40p
S08 (800)	55p

BRIDGE RECTIFIERS
(PIV shown in brackets)
1 amp type

W01 (100)	20p
W02 (200)	26p
W04 (400)	28p
W08 (800)	40p

6 amp type
Square with hole

PW01 (100)	50p
PW02 (200)	78p
PW04 (400)	85p
PW06 (600)	90p

25 amp type
Metal clad with hole

K01 (100)	2.20
K02 (200)	2.30
K04 (400)	2.80
K06 (600)	3.40

Proprietory Bridges

B40C1500	1.20
B80C3700	1.80
BY164	55p
BY179	92p

ZENER DIODES
400-500 mW
E24 Series
2.4-47 V 8p

1.3 Watt
E24 Series
3.3-82 V 15p

2.5 Watt
E24 Series
7.5-75V 1.10

5W wire ended following voltages only 3V3, 3V6, 4V3, 4V7, 5V6, 7V5, 8V2, 8V7, 9V1, 10V, 12V, 20V, 33V, 51V, 62V, 68V 1.25

10W Pos. Stud
Following voltages only 7V5, 13, 18, 20, 24, 27, 30, 33, 68, 82, 91, 100, 110 1.25

20W Pos. Stud
(BZY93 series)
E24 values
7V5-75V 2.00

OPTO ELECTRONICS

2N5777	78p
2N5778	88p
2N5779	1.09
4N25	1.10
BP100	1.40
BP104	1.00
BPX25	2.47
BPX29	2.47
BPX48	6.76
BPX60	4.75
BPX61	3.48
BPX63	2.93
BPX79	4.60
BPX86	4.15
CQX13	40p
CQX23	53p
CQX33	48p
LD30A	10p
LD36A	12p
LD37A	12p
LD52A	12p
LD56A	15p
LD57A	15p
LD52C	30p
LD56C	30p
LD57C	30p
LD80A	18p
LD86A	22p
LD87A	22p
LD242	75p
LD271	40p
LD461	25p
LD466	1.45
LD468	1.65
LD471	27p
LD476	1.20
LD478	1.45
LD479	1.65
LD481	27p
LD486	1.25
LD488	1.70
LD489	1.89
LD599	81p
ORP12	1.20
RPY60	2.65
RPY63	2.65
TIL32	71p
TIL63	1.95
TIL64	1.95
TIL65	2.25
TIL66	2.30
TIL67	2.35
TIL78	60p
TIL81	1.60
TIL99	1.35
TIL116	1.10
TIL138	2.40
TIL139	2.40
TIL209	15p
TIL211	19p
TIL212	19p
TIL224	32p
TIL228	42p
TIL312	1.65
TIL313	1.65
TIL401	3.50
TIL403	3.80
TIL406	4.10

NEW OPTO DEVICES

inc. Superbright see next column.

POWERFET AMP MODULES FROM PANTECHNIC
now available from LONDON. Send s.a.e. for specs.

PFA 100	16.00
PFA 200	22.55
10,000 mF 80 V	4.10

D. CONNECTORS 25 WAY
Solder type

Male	1.60
Fmale	2.05

Angled PCB

Male	2.45
Fmale	2.90
Covers	99p

NEW OPTO DEVICES
New LEDs
Now in stock
R = red
G = green
Y = yellow
Large diffused

	1+	50+
R5D	9p	7p
G5D	15p	12p
Y5D	15p	12p

Small diffused

R2D	8p	6p
G2D	12p	10p
Y2D	12p	10p

Micro 0.1"

R1D	25p	22p
G1D	27p	25p
Y1D	27p	25p

Large clear

R5C	12p	10p
G5C	17p	13p
Y5C	17p	13p

Super bright
Large (100 times brighter)

R5U	38p	29p
G5U	42p	34p
Y5U	42p	34p

Tri-colour flat

RGY8	83p	78p

LINEAR ICs

AN103	2.20
AY1-0212	6.60
AY3-0215	7.95
AY1-1320	2.20
AY1-5050	95p
AY1-1270	7.26
AY3-8910	5.39
AY3-8912	5.59
AY5-2376	5.89
CA3000	4.80
CA3001	4.95
CA3002	4.60
CA3005	3.15
CA3007	4.92
CA3010	1.30
CA3012	1.75
CA3013	4.12
CA3014	2.35
CA3015	2.62
CA3018	75p
CA3018A	2.00
CA3020	2.00
CA3020A	3.90
CA3021	3.20
CA3022	3.12
CA3026	1.52
CA2028A	1.21
CA3028B	2.53
CA3029	1.44
CA3030A	2.97
CA3033	5.44
CA3034	5.18
CA3036	2.75
CA3039	1.50
CA3041	3.47
CA3042	3.47
CA3043	3.92
CA3046	69p
CA3047	4.60
CA3048	2.99
CA3049	3.21
CA3050	4.11
CA3051	3.80
CA3052	2.92
CA3053	1.00
CA3054	1.66
CA3059	2.80
CA3060	4.09
CA3062	13.84
CA3065E	4.62
CA3068	4.23
CA3070	3.20
CA3071	3.30
CA3075	2.25
CA3076	3.42
CA3078T	2.25
CA3080	1.89
CA3080A	3.95
CA3080E	70p
CA3081	1.90
CA3085	1.35
CA3086	55p
CA3089E	1.95
CA3090AQ	3.70
CA3130E	87p
CA3130T	1.80
CA3140E	39p
CA3140T	85p
HA1366W	2.40
HA1388	2.54
ICL7106	7.40
ICL7107	9.50
ICL8038	2.99
ICM7555	80p
LC7120	3.20
LC7130	3.20
LF351	47p
LF353	92p
LF355	83p
LF356	92p
LF357	1.09
LF13201	2.99
LF13331	3.30
LF13741H	68p
LF13741N	59p
LM10CH	4.25
LM11CH	4.50
LM114	6.75
LM137K	11.52
LM301AH	1.00
LM301AN	25p
LM305AH	2.90
LM305H	88p
LM307H	1.05
LM307N	55p
LM308AH	3.15
LM308AN	2.14
LM308H	95p
LM308N	88p
LM309K	2.80
LM310H	1.95
LM310N	1.89
LM311H	1.04
LM311N	70p
LM317K	2.80
LM317MP	1.04
LM318H	2.40
LM318N	1.49
LM319H	2.48
LM319N	2.10
LM320 – See 79XX Series Volt Regulators	
LM324N	29p
LM337K	4.75
LM337MP	1.65
LM337T	1.99
LM339AN	1.60
LM339N	47p
LM340 – See 78XX Series Volt Regulators	
LM345K	3.60
LM348N	62p
LM349N	1.16
LM350K	4.60
LM359N	1.44
LM360N	3.88
LM376N	65p
LM377N	1.69
LM378N	3.40
LM379S	4.79
LM380N14	75p
LM380N8	1.50

LM381AN	2.26
LM381N	1.40
LM382N	1.12
LM383T	3.40
LM384N	1.40
LM386N1	88p
LM386N4	1.20
LM388N	2.43
LM391N60	1.70
LM391N80	1.93
LM392N	76p
LM393N	96p
LM394H	3.80
LM396K	13.52
LM709N8	64p
LM709CH	1.00
LM710CH	89p
LM710CN	52p
LM711CH	1.38
LM711CN	70p
LM723CH	1.21
LM723CN	40p
LM725CH	3.40
LM725CN	3.15
LM733CN	69p
LM741CH	96p
LM741CN	15p
LM741CN14	80p
LM747CN	69p
LM748CH	1.00
LM748CN	35p
LM1303N	1.20
LM1304N	2.50
LM1305N	3.10
LM1307N	2.75
LM1310N	1.45
LM1330N	2.25
LM1458	44p
LM1496	1.08
LM1800	3.24
LM1801	2.99
LM1812	8.00
LM1818	2.99
LM1820	2.15
LM1828	4.79
LM1830	2.44
LM1845	4.12
LM1848	2.89
LM1850	2.75
LM1871	4.39
LM1872	4.39
LM1886	7.44
LM1889	3.77
LM2907N	2.75
LM2907NB	2.60
LM2917N	1.89
LM2917N8	1.89
LM3524	6.77
LM3301	1.60
LM3302	74p
LM3401	65p
LM3404	75p
LM3405	1.45
LM3900	48p
LM3905	1.25
LM3909	79p
LM3911	1.20
LM3914	1.79
LM3915	1.99
LM3916	2.19
LM4250CH	2.63
LM4250N	2.39
LM13600	1.09
MB3712	1.99
MB3756	3.80
MB8719	7.95
M53200	8.54
MC1303=	
LM1303N	
MC1304=	
LM1304N	
MC1305=	
LM1305N	
MC1307=	
LM1307N	
MC1310=	
LM13010N	
MC1330=	
LM1330N	
MC1352	1.75
MC1456	1.80
MC1458=	
LM1458	
MC1466L	6.77
MC1495L	3.75
MC1496=	
LM1496	
MC3340	1.45
MC3401=	
LM3401	
MC3403=	
LM3403	
MC3405=	
LM3405	
NE531N	1.36
NE543N	2.50
NE544N	1.80
NE555	16p
NE556	45p
NE558	1.89
NE560	3.25
NE562	4.09
NE565	1.18
NE566	1.49
NE567	1.37
NE570	3.75
NE571	3.75
NE5534	1.49
PLL02A	4.95
PLL03A	12.75
RCA136	59p
S566B	2.59
SAD1024A	8.49
SAS560	2.59
SAS570	2.59
SAS580	2.59
SAS590	2.59
SFF96364	7.99
SL610C	4.00
SL611C	4.00
SL612C	4.00
SL620C	6.00
SL621C	6.00
SL623C	10.00
SL630C	6.00
SL640C	6.00
SL641C	6.00
SN76001N	2.80
SN76008	3.90
SN76018	3.90
SN76003N	2.95
SN76013N	2.95
SN7023N=	
SN76033N	
SN76033N	2.95
SN76110	2.25
SN76115	2.65
SN76116	2.75
SN76226	3.45
SN76228	2.90
SN76477	4.49
SN76530	1.80
SN76550	80p
SN76666	2.90
SO41P	1.60
SO42P	1.60
TA7210	1.49
TA7204	1.95
TA7205	89p

TA7222	1.45
TA7310	1.49
TAA263	1.50
TAA300	3.95
TAA320	2.05
TAA350	3.60
TAA521	1.50
TAA522	2.47
TAA550	73p
TAA560	2.35
TAA570	2.35
TAA621AX1	2.75
TAA661A	1.50
TAA661B	1.70
TAA700	2.60
TAA930	2.50
TAA930B	2.63
TAA970	2.45
TAA991D	2.45
TAD100	2.00
TBA120AS	69p
TBA331	1.50
TBA341	2.05
TBA395	1.65
TBA396	1.50
TBA450	1.95
TBA460	1.53
TBA500	2.97
TBA500Q	3.11
TBA510	2.95
TBA510Q	3.05
TBA520	2.57
TBA520Q	2.75
TBA530	2.55
TBA530Q	2.76
TBA540	2.72
TBA540Q	2.74
TBA550	3.25
TBA550Q	3.27
TBA560C	2.87
TBA570	2.37
TBA570Q	2.48
TBA581	3.11
TBA641	3.00
TBA651	1.90
TBA673	4.15
TBA700	2.38
TBA700Q	2.47
TBA720AQ	2.60
TBA750	2.25
TBA750Q	2.46
TBA790A	2.11
TBA800	78p
TBA810	95p
TBA820	75p
TBA820M	75p
TBA920	1.95
TBA920Q	1.97
TBA950	2.25
TBA990	2.65
TBA990Q	2.74
TCA105	3.00
TCA160C	2.67
TCA220	3.44
TCA270	2.44
TCA440	2.20
TCA450	2.65
TCA640	4.15
TCA650	4.15
TCA660B	4.15
TCA730	4.80
TCA740	4.80
TCA750	4.85
TCA760	2.75
TCA800	3.50
TBA800Q	3.60
TCA830S	1.90
TCA910	2.19
TCA940	1.69
TDA1002	3.39
TDA1003	3.94
TDA1004	3.94
TDA1005	3.94
TDA1010A	1.79
TDA1022	4.95
TDA1024	1.19
TDA1034	3.20
TDA2020	2.99
TDA2030	2.85
TDA2522	4.20
TDA2530	3.30
TDA2540	4.10
TDA2541	4.10
TDA2560	4.10
TDA2571	4.40
TDA2581	3.75
TDA2590	5.20
TDA2591	4.73
TDA2600	6.15
TDA2610	3.90
TDA2611A	2.50
TDA2640	3.64
TDA3000	2.76
TL061	40p
TL062	60p
TL064	99p
TL071	36p
TL072	50p
TL074	1.30
TL081	50p
TL082	75p
TL083	85p
TL084	89p
TL170	49p
TL430	69p
UAA170	1.69
UAA180	1.69
ULN2003	85p
UPC575C2	2.65
UPC1156	2.75
XR2206	2.92
ZN414	79p
ZN419	2.25
ZN1034	1.99
ZN1040	6.69
ZTK22	89p
ZTK33	89p

TTL

7400	10½p
7401	11p
7402	11p
7403	12p
7404	12p
7405	15p
7406	20p
7407	20p
7408	14p
7409	14p
7410	14p
7411	16p
7412	18p
7413	18p
7414	25p
7416	20p
7417	20p
7420	15p
7421	20p
7422	20p
7423	20p
7425	24p
7426	28p
7427	22p
7428	26p
7430	14p
7432	22p
7433	22p
7437	25p
7438	25p
7440	15p
7441	65p
7442	32p
7443	90p
7444	90p
7445	50p
7446	60p
7447	40p
7448	44p
7450	15p
7451	15p
7453	15p
7454	14p
7460	15p
7470	34p
7472	25p
7473	25p
7474	20p
7475	25p
7476	28p
7480	49p
7481	1.19
7482	68p
7483	38p
7484	69p
7485	60p
7486	20p
7489	2.20
7490	20p
7491	35p
7492	25p
7493	25p
7494	36p
7495	36p
7496	40p
7497	90p
74100	80p
74104	50p
74105	55p
74107	22p
74109	25p
74110	35p
74116	50p
74118	59p
74119	80p
74120	59p
74121	25p
74122	40p
74123	40p
74125	35p
74126	34p
74128	36p
74132	29p
74136	30p
74141	55p
74142	1.99
74143	2.48
74144	2.10
74145	50p
74147	89p
74148	70p
74150	49p
74151	40p
74153	40p
74154	49p
74155	40p
74156	40p
74157	30p
74159	75p
74160	60p
74161	48p
74162	48p
74163	48p
74164	48p
74165	48p
74166	48p
74170	1.25
74172	2.75
74173	60p
74174	59p
74175	49p
74176	39p
74177	45p
74178	79p
74180	40p
74181	1.15
74182	60p
74184	90p
74185	90p
74186	4.69
74188	2.50
74190	48p
74191	48p
74192	45p
74193	45p
74194	45p
74195	46p
74196	45p
74197	48p
74198	83p
74199	83p
74221	53p

74LS TTL

74LS00	11p
74LS01	11p
74LS02	11p
74LS03	12p
74LS04	12p
74LS05	12p
74LS08	12p
74LS10	12p
74LS11	12p
74LS12	12p
74LS13	19p
74LS14	30p
74LS15	12p
74LS20	12p
74LS21	12p
74LS22	12p
64LS27	12p
74LS28	14p
74LS30	12p
74LS32	13p
74LS33	14p
74LS37	14p
74LS38	15p
74LS40	13p
74LS42	28p
74LS47	35p
74LS51	14p
74LS54	14p
74LS55	14p
74LS73	18p
74LS74	18p
74LS75	20p
74LS76	20p
74LS78	18p
74LS80	1.20
74LS83	36p
74LS85	48p
74LS86	16p
74LS90	24p
74LS92	25p
74LS93	24p
74LS95	39p
74LS96	96p
74LS107	20p
74LS109	27p
74LS112	22p
74LS113	22p
74LS114	22p
74LS122	36p
74LS123	36p
74LS124	89p
74LS125	24p
74LS126	25p
74LS132	39p
74LS136	29p
74LS138	32p
74LS139	30p
74LS145	70p
74LS147	1.57
74LS148	75p
74LS151	39p
74LS153	39p
74LS154	79p
74LS155	29p
74LS156	36p
74LS157	27p
74LS158	29p
74LS160	35p
74LS161	35p
74LS162	35p
74LS163	35p
74LS164	40p
74LS165	59p
74LS168	84p
74LS169	85p
74LS170	70p
74LS173	55p
74LS174	45p
74LS175	39p
74LS181	99p
74LS183	1.79
74LS190	36p
74LS191	36p
74LS192	36p
74LS193	37p
74LS194	32p
74LS195	32p
74LS196	45p
74LS197	48p
74LS221	50p
74LS240	55p
74LS241	55p
74LS242	55p
74LS243	55p
74LS244	60p
74LS245	70p
74LS247	50p
74LS248	55p
74LS249	55p
74LS251	30p
74LS253	32p
74LS257	35p
74LS258	35p
74LS259	55p
74LS261	1.35
74LS266	18p
74LS273	60p
74LS275	2.25
74LS279	30p
74LS280	1.60
74LS283	40p
74LS289	4.70
74LS290	45p
74LS293	40p
74LS295	89p
74LS298	89p
74LS299	2.50
74LS323	1.76
74LS324	1.45
74LS325	2.96
74LS326	2.39
74LS327	2.39
74LS347	95p
74LS348	1.00
74LS352	79p
74LS353	79p
74LS362	7.25
74LS365	29p
74LS366	29p
74LS367	29p
74LS368	29p
74LS373	59p
74LS378	58p
74LS386	1.14
74LS390	46p
74LS393	42p
74LS395	89p
74LS396	1.90
74LS398	2.70
74LS399	1.59
74LS445	99p
74LS490	2.20
74LS540	77p
74LS541	99p
74LS640	1.60
74LS641	1.69
74LS643	2.25
74LS644	2.75
74LS669	1.20
74LS670	1.40
74LS673	5.50
74LS674	9.99
74LS688	1.19

74S TTL

74S00	30p
74S02	32p
74S04	32p
74S08	75p
74S20	60p
74S30	60p
74S32	70p
74S40	1.45
74S64	1.02
74S65	1.02
74S74	75p
74S85	2.99
74S86	1.75
74S112	90p
74S113	90p
74S124	2.95
74S132	1.09
74S133	60p
74S138	1.25
74S139	1.49
74S140	2.50
74S153	7.95
74S157	2.75
74S163	3.00
74S174	2.50
74S175	3.20
74S188	3.50
74S189	3.50
74S194	3.50
74S200	4.50
74S201	4.00
74S225	5.25
74S261	3.00
74S262	8.50
74S287	2.99
74S288	1.99
74S289	1.57
74S301	3.20
74S470	3.25
74S471	6.25
74S473	12.50
74S474	3.99
74S475	8.25
74S571	9.00
74S573	9.00

74H TTL

74H00	1.45
74H01	1.45
74H04	1.55
74H05	1.55
74H10	1.45
74H11	1.45
74H20	1.45
74H21	1.45
74H30	1.45
74H40	1.55
74H51	1.75
74H53	1.65
74H54	1.45
74H55	1.40
74H60	1.70
74H62	1.75
74H62	1.75

74L TTL

74L02	1.00
74L10	1.70
74L47	3.27
74L74	1.20
74L85	4.20
74L86	1.50
74L93	2.30
74L98	2.99

74 CMOS/TTL

74C00	27p
74C04	29p
74C10	28p
74C14	89p
74C20	28p
74C30	36p
74C42	96p
74C48	1.40
74C73	54p
74C76	57p
74C83	1.74
74C85	1.34
74C86	1.10
74C89	5.95
74C90	1.05
74C93	1.44
74C95	1.00
74C107	60p
74C151	2.55
74C154	4.95
74C157	2.20
74C160	1.54
74C161	1.15
74C162	1.16
74C163	65p
74C164	1.15
74C165	2.00
74C173	98p
74C174	65p
74C175	75p
74C192	89p
74C193	68p
74C194	89p
74C195	70p
74C200	10.00
74C221	1.20
74C901	1.91
74C902	71p
74C903	2.30
74C904	1.84
74C905	10.88
74C907	1.91
74C908	1.87
74C911	9.59
74C912	8.00
74C914	2.88
74C915	1.99
74C918	2.50
74C920D	8.50
74C922	4.50
74C923	5.00
74C925	6.00
74C926	6.58
74C928	6.00
74C929	5.20
74C930J	7.80
74C932	3.12

40 CMOS

4000	10p
4001	10p
4002	11p
4006	49p
4007	15p
4008	32p
4009	24p
4010	10p
4011	10p
4012	15p
4013	20p
4014	46p
4015	58p
4016	20p
4017	32p
4018	45p
4019	26p
4020	44p
4021	39p
4022	48p
4023	12p
4024	32p
4025	12p
4026	79p
4027	20p
4028	29p
4029	29p
4030	14p
4031	1.19
4032	80p
4033	1.20
4035	1.29
4035	59p
4036	2.49
4037	1.30
4038	99p
4039	2.80
4040	46p
4041	40p
4042	39p
4043	46p
4044	41p
4045	99p
4046	44p
4047	39p
4048	39p
4049	22p
4050	23p
4051	44p
4052	49p
4053	49p
4054	79p
4055	83p
4056	89p
4059	4.35
4060	42p
4063	79p
4066	22p
4067	2.49
4068	14p
4069	13p
4070	13p
4071	13p
4072	13p
4073	13p
4075	13p
4076	45p
4077	13p
4078	13p
4081	12p
4082	12p
4085	49p
4086	53p
4089	1.50
4093	20p
4094	69p
4095	66p
4096	90p
4097	2.88
4098	74p
4099	90p

For higher numbers in 40 Series, substitute 74C for 40 prefix. eg 40107 = 74C107

45 CMOS

4502	59p
4503	29p
4507	33p
4508	1.19
4510	35p
4511	48p
4512	39p
4514	1.17
4515	1.17
4516	59p
4518	39p
4519	29p
4520	48p
4521	99p
4526	59p
4527	59p
4528	46p
4532	69p
4534	4.29
4536	2.59
4538	65p
4539	99p
4543	56p
4553	2.25
4555	35p
4556	35p
4560	1.49
4566	1.49
4569	1.59
4584	39p
4585	79p

COMPUTER ICs
CPUs

1802	7.00
2650A	11.99
6502	3.24
6800	2.74
6802	2.69
6809	8.50
8035	3.49
8060	10.90
8080A	2.79
8085A	3.49
8900	57.75
9980	21.00
SCMP1	17.66
Z80A	2.96

MEMORIES

1702A	3.50
2101	4.00
2102AL2	1.35
2111-1	3.00
2114(200ns)	80p
2532	3.60
2708	2.25
2716 (5v)	2.11
4027	3.00
4044	7.00
4060	9.50
4116(200ns)	75p
4118-3	3.25
4164	4.50
5204	7.50
6116	4.40
6514	3.30
6810	1.15
7489	4.20
74189	4.00
74LS289	3.25
74LS188	2.25
74LS287	3.05
74LS288	2.25

ZERO INSERTION DIL SOCKETS

24pin	4.90
40pin	5.30

LOGIC ICs
including
COMPUTER SUPPORT

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8T95	1.35
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81LS96	1.20
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6852	2.40
6875	4.85
8131	3.75
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8216	1.00
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VOLTAGE REGULATORS
(See also Linear ICs)
– Positive –
100 mA

78L05A	30p
78L12A	30p
78L15A	30p
78L24A	30p

100 mA TO5

78L05CH	80p
78L12CH	80p
78L15CH	80p
78L24CH	80p

500 mA TO202

7805M	47p
7812M	47p
7815M	47p
7842M	47p

1 Amp TO220

7805T	39p
7812T	39p
7815T	39p
7824T	39p

1.5 Amp TO03

7805K	1.39
7812K	1.39
7815K	1.39
7824K	1.39

– Negative –
100 mA TO92

79L05	59p
79L12	59p
79L15	59p

500 mA TO202

7905M	55p
7912M	55p
7915M	55p
7924M	55p

1 Amp. TO220

7905T	44p
7912T	44p
7915T	44p
7924T	44p

1.5 Amp. TO3

7905K	1.99
7912K	1.99
7915K	1.99
7924K	1.99

– Variable –

L200 (2A Pos)	2.50
LM137K	12.00
LM309K	1.35
LM317K	3.42
LM317MP	95p
LM317T	1.75
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All Metal

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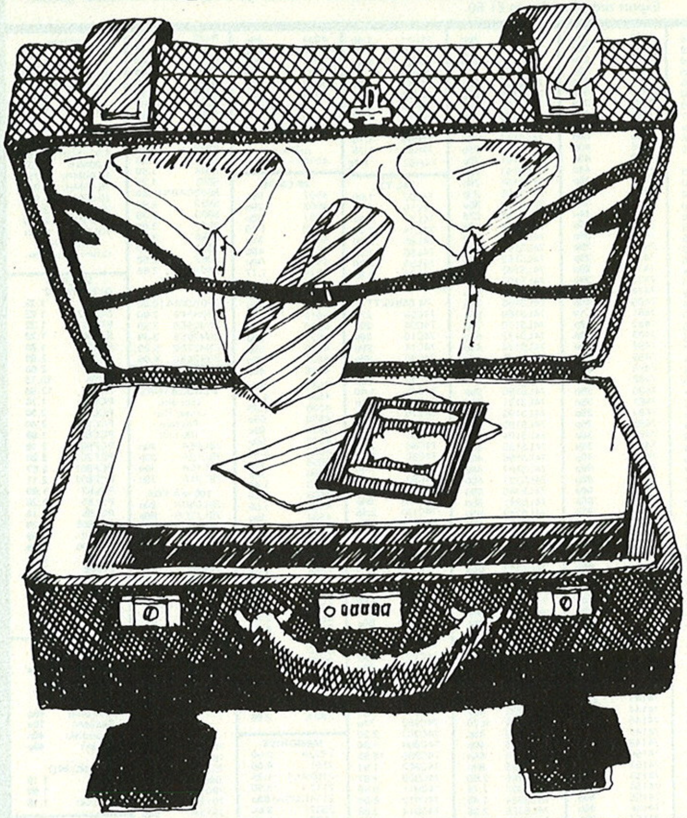

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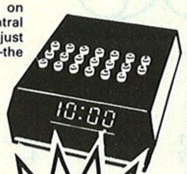

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- Direct switch control enabling output to be turned on immediately or after a specified time interval.
- 20 function keypad for programme entry.
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(Kit includes all components, PCB, assembly and programming instructions).

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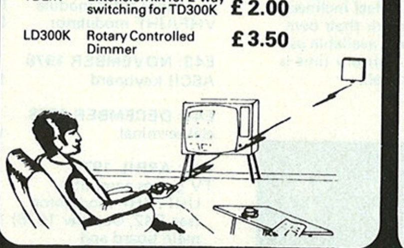
These kits contain all necessary components and full instructions & are designed to replace a standard wall switch and control up to 300w. of lighting.

TDR300K	Remote Control Dimmer	**£14.30**
MK6	Transmitter for above	**£ 4.20**
TD300K	Touchdimmer	**£ 7.00**
TDE/K	Extension kit for 2-way switching for TD300K	**£ 2.00**
LD300K	Rotary Controlled Dimmer	**£ 3.50**



MINI KITS

MK1 TEMPERATURE CONTROLLER/THERMOSTAT
Uses LM3911 IC to sense temperature (80°C max.) and triac to switch heater. 1KW **£4.00**

MK2 Solid State Relay
Ideal for switching motors, lights, heaters, etc. from logic. Opto-isolated with zero voltage switching. Supplied without triac **£2.60**

MK3 BAR/DOT DISPLAY
Displays an analogue voltage on a linear 10 element LED display as a bar or single dot. Ideal for thermometers, level indicators, etc. May be stacked to obtain 20 to 100 element displays. Requires 5-20V supply. **£4.50**

MK4 PROPORTIONAL TEMPERATURE CONTROLLER
Based on the SL441 zero voltage switch, this kit may be wired to form a "burst fire" power controller, enabling the temperature of an enclosure to be maintained to within 0.5°C. Max. load 3KW **£5.55**

MK5 MAINS TIMER
Based on the ZN1034E Timer IC this kit will switch a mains load on (or off) for a preset time from 20 mins. to 35 hrs. Longer or shorter periods may be realised by minor component changes. Max. load 1KW. **£4.50**

♪ 3-NOTE DOOR CHIME ♫♪

Based on the SAB0600 IC the kit is suppied with all components, including loudspeaker, printed circuit board, a pre-drilled box (95 x 71 x 35mm) and full instructions. Requires only a PP3 9V battery and push-switch to complete. AN IDEAL PROJECT FOR BEGINNERS.
Order as XK102. **£5.00**

For a detailed booklet on remote control – send us 30p & SAE today.

THE HOME CONTROL CENTRE

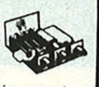
This New Remote Control Kit enables you to control up to 16 different appliances anywhere in the house from the comfort of your armchair. The transmitter injects coded pulses into the mains wiring which are received by receiver modules connected to the same mains supply and used to switch on the appliance addressed. Receivers are addressed by means of a 16-way keyboard, followed by an on or off command. Since pushing buttons can become rather boring, the transmitter also includes a computer interface so you can programme your favourite micro to switch lights, heating, electric blanket, make your coffee in the morning, etc. without rewiring your house. **JUST THINK OF THE POSSIBILITIES.** The KIT includes all PCBs and components for one transmitter and two receivers plus a pre-drilled box for the transmitter.

Order as XK112

£42.00

DISCO LIGHTING KITS

DL 1000K



This value-for-money kit features a bi-directional sequence, speed of sequence and frequency of direction change, being variable by means of potentiometers and incorporates a master dimming control. **Only £14.60**

DLZ100K
A lower cost version of the above, featuring undirectional channel sequence with speed variable by means of a pre-set pot. Outputs switched only at mains zero crossing points to reduce radio interference to a minimum. **Only £8.00**

Optional opto input DLA1
Allowing audio ("beat")—light response. **60p**

NEW DL3000K
This 3 channel sound to light kit features zero voltage switching, automatic level control & built in mic. No connections to speaker or amp required. No knobs to adjust – simply connect to mains supply & lamps.
(1Kw/Channel) **Only £11.95**

"OPEN-SESAME"

The XK103 is a general purpose infra-red transmitter/receiver with one momentary (normally open) relay contact and two latched transistor output. Designed primarily for controlling motorised garage doors and two auxillary outputs for drive/garage lights at a range of up to 40 ft. The unit also has numerous applications in the home for switching lights, TV, closing curtains, etc. Ideal for aged or disabled persons.

The kit comprises a mains powered receiver, a four button transmitter, complete with pre-drilled box, requiring a 9V battery and one opto-isolated solid state switch kit for interfacing the receiver to mains appliances. As with all our kits, full instructions are supplied.

Only £23.75

Extra Solid State Switch Kits (XK104) and transmitters (XK105) can be supplied.

XK104 £2.40 **XK105 £10.50**

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DVM/ULTRA SENSITIVE THERMOMETER KIT

This new design is based on the ICL7126 (a lower power version of the ICL7106 chip) and a 3½ digit liquid crystal display. This kit will form the basis of a digital multimeter (only a few additional resistors and switches are required—details supplied), or a sensitive digital thermometer (–50°C to +150°C) reading to 0.1°C. The basic kit has a sensitivity of 200mV for a full scale reading, automatic polarity indication and an ultra low power requirement—giving a 2 year typical battery life from a standard 9V PP3 when used 8 hours a day, 7 days a week.

REMOTE CONTROL KITS

MK6 SIMPLE INFRA RED TRANSMITTER
Pulsed infra red source complete with hand-held plastic box. Requires a 9V battery. **£4.20**

MK7 INFRA RED RECEIVER
Single channel, range approx. 20ft. Mains powered with a triac output to switch loads up to 500W at 240V ac. **£9.00** (RC500K –Special Price for MK6 and MK7 together **£12.50**

MK8 CODED INFRA RED TRANSMITTER
Based on the SL490, the kit includes all components to make a coded transmitter and only requires a 9V (PP3) battery and keyboard. 8 x 2 x 1.3cms **£5.90**

MK10 16-WAY KEYBOARD
For use with MK8 and MK18 to generate 16 different codes for decoding by the ML928 or ML926 receiver (MK12) kit. **£5.40**

MK11 10-Channel + 3 Analogue o/p IR Receiver
Based on ML922 decoder IC. Functions include on/standby output, toggle, control of volume, tone and lamp brightness. Includes its own mains supply. **£12.00**

MK12 16-CHANNEL IR RECEIVER
For use with MK8 kit with 16 on/off outputs, which with further interface circuitry, such as relays or triacs, will switch up to 16 items of equipment on or off remotely. Latched or momentary outputs – please specify when ordering. Includes its own mains supply. **£11.95**

MK13 11-WAY KEYBOARD For use with MK8, MK18 and MK11 kits. **£4.35**

MK16 Mains Powered IR Transmitter
Mains powered for continuous operation – single channel, for applications such as burglar alarms, automatic door openers, etc. Range approx. 6 ft. **£2.50**

MK17 12V d.c. IR RECEIVER
For use with MK6 or MK16. Relay output with DP 3 Amp change-over contacts, may be used as latched, momentary or "break beam" receiver. Operates from 6-13V d.c. **£9.50**

MK18 HIGH POWER IR TRANSMITTER
Similar to MK8 but with range of approx. 60ft. **£6.20**

Ancillary Kits : MK2 Solid State Relay
Opto-isolated with zero voltage switching. No. triac supplied. **£2.60**

MK15 DUAL LATCHED SOLID STATE RELAY
Comprises 2 x solid state relays and latch for use with momentary version of the MK12. 2 output triacs required (not supplied). **£4.50**

We have the SOFTY 2 EPROM programmer in stock at £169

THE KEY TO YOUR SECURITY IS IN OUR LOCK

If the thought of car thieves, house breakers or people tampering with your electrical and electronic equipment upsets you, we have just the kit for you.
Our ELECTRONIC LOCK KIT includes 10-way keyboard and a special IC which provides a 750mA output to drive a solenoid or relay (not supplied) when four keys are depressed in the correct sequence. This gives over 5,000 possible combinations! The sequence is prewired and may be easily changed by means of a small plug and socket. A "SAVE" function is also available enabling the open code to be stored (especially useful in a car when it is left in a garage for servicing as the open code need not be disclosed). Size: 7x6x3 cms. Power Consumption is 40uA at 5V to 15V d.c.

At only **£10.50 + VAT**, it will make a smaller hole in your pocket than a bunch of keys!

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Suitable for use with existing door locks and above electronic lock kit. **£13.50**

FREE **SHORT FORM CATALOGUE** – send SAE (6" x 9"). We also stock Vero, Books, Resistors, Capacitors, Semi-Conductors etc.

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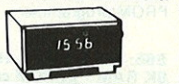
Switches any appliance up to 1kW on and off at present times once per day. Kit contains: AY-5-1230 IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triacs, PCBs and full instructions.



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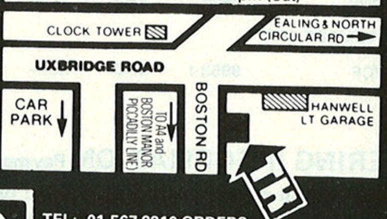
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Example:

digisplay	(E13)	9376	3.25	7.25
1	2	3	4	5

1. Circuit title
2. reference to associated article(s)
3. board number

U.K.:

4. price (in £) inclusive of 15% VAT

U.S.A. and Canada:

5. price in $, not including tax (if any)

		£	$
E26: JUNE 1977			
formant: keyboard interface (E25)	9721-1	3.35	8.—
E29: SEPTEMBER 1977			
formant (E25, E26):			
interface receiver	9721-2	1.40	3.50
power supply	9721-3	5.50	13.—
keyboard divider (one octave)	9721-4	1.30	3.—
E31: NOVEMBER 1977			
formant (E25 . . . E30): VCO	9723-1	9.90	23.50
experimenting with the SC/MP:			
RAM-I/O	9846-1	6.90	16.50
SC/MP board	9846-2	2.60	6.—
E32: DECEMBER 1977			
formant (E25 . . . E31): VCF	9724-1	4.35	10.50
experimenting with the SC/MP (E31): CPU	9851a	12.90	31.—
E33: JANUARY 1978			
simple function generator	9453	3.25	8.—
formant (E25 . . . E32): ADSR	9725-1	4.20	10.—
UAA 180 LED voltmeter (two boards)	9817	2.70	6.50
experimenting with the SC/MP (E31, E32):			
bus board (E57)	9857	4.—	9.50
memory card	9863	12.60	30.—
E34: FEBRUARY 1978			
formant (E25 . . . E33): DUAL-VCA	9726-1	4.35	10.50
experimenting with the SC/MP (E31 . . . E33): HEX-I/O	9893	18.20	43.50
E35: MARCH 1978			
formant (E25 . . . E34):			
LFO module	9727-1	4.50	11.—
noise module	9728-1	4.—	9.50
4 k RAM card	9885	14.70	35.—
SC/MP power supply	9906	4.05	9.50
E36: APRIL 1978			
formant (E25 . . . E35): COM	9729-1	4.—	9.50
elektornado	9874	3.55	8.50
cassette interface	9905	3.—	7.—
E38: JUNE 1978			
mini-counter	9927	3.15	7.50
E39/40: SUMMER CIRCUITS 1978			
touch dimmer	78065	1.30	3.—
preconsonant	9954	2.25	5.50
E41: SEPTEMBER 1978			
formant 24 dB VCF	9953-1	4.10	10.—
E42: OCTOBER 1978			
resonance filter module	9951	4.45	10.50
VHF/UHF modulator	9967	1.55	4.—
E43: NOVEMBER 1978			
ASCII keyboard	9965	7.70	18.50
E44: DECEMBER 1978			
elekterminal	9966	7.50	18.—
E48: APRIL 1979			
TV games computer:			
UHF/VHF modulator (see E42, October 1978)	9967	1.55	4.—
main board and documentation	79073	19.95	47.50
power supply	79073-1	2.45	6.—
keyboard p.c.b.	79073-2	3.65	8.50
Complete set of four boards (9967, 79073, 79073-1, 79073-2), documentation and one ESS software record (ESS 006):		26.25	62.50
E49: MAY 1979			
BASIC microcomputer	79075	6.40	15.—
interface for µPs	79101	1.40	3.50
E50: JUNE 1979			
stereo decoder	79082	2.40	5.50
E53: SEPTEMBER 1979			
parametric equaliser,			
filter section	9897-1	1.65	4.—
tone control section	9897-2	1.65	4.—
E55: NOVEMBER 1979			
topamp	80023	1.45	3.50
E56: DECEMBER 1979			
SEWAR	80009	2.85	7.—
steam train	80019	1.90	4.50
E57: JANUARY 1980			
digital tuning scale (two boards)	80021-1/2	7.05	17.—
new bus board (E33)	80024	5.85	14.—
talk funny (E56)	80054	1.55	3.50
E58: FEBRUARY 1980			
aerial amplifier	80022	1.85	4.50
elektor vocoder,			
bus board 1	80068-1	9.90	23.50
bus board 2	80068-2		
filter board	80068-3	3.45	8.—
input/output board	80068-4	3.20	7.50
supply board	80068-5	2.85	7.—
E59: MARCH 1980			
chorosynth	80060	22.15	53.—
E60: APRIL 1980			
aide-de-camp: 12 V/2 A	7043B	1.10	2.50
transistor ignition	80084	3.90	9.50
E61: MAY 1980			
BASIC cassette interface	80050	5.60	13.50
PWM amplifier	80085	1.50	3.50
Junior computer:			
main board	80089-1	12.60	30.—
display board	80089-2	1.30	3.—
supply board	80089-3	3.—	7.—
E62: JUNE 1980			
pest pester	80130	1.10	2.50
E63/64: SUMMER CIRCUITS 1980			
STAMP amplifier	80543	1.40	3.50
PROM programmer	80556	3.85	9.—
E65: SEPTEMBER 1980			
8K RAM + EPROM card	80120	13.15	31.50
E67: NOVEMBER 1980			
central heating pump control	81019	2.55	6.—
fridge alarm	81024	1.45	3.50
E69: JANUARY 1981			
disco ceiling lights	81012	8.70	20.50
big VU meter			
low voltage board	81085-1	2.30	5.50
main board	81085-2	2.45	6.—
E70: FEBRUARY 1981			
voiced/unvoiced detector			
detector board	81027-1	3.40	8.—
switch board	81027-2	4.05	9.50
E71: MARCH 1981			
movement detector	81110	2.35	5.50
MW receiver	81111	1.95	4.50
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E72: APRIL 1981			
transistor match-maker	81123	1.75	4.—
intelekt	81124	5.65	13.50
universal power supply	81128	2.45	6.—
E73: MAY 1981			
logic analyser:			
main board	81094-1	8.35	20.—
input board	81094-2	2.15	5.—
memory board	81094-3	2.15	5.—
cursor board	81094-4	3.25	7.50
display board	81094-5	1.45	3.50
E74: JUNE 1981			
Junior Computer			
interface board	81033-1	19.05	45.50
−12 V supply	81033-2	1.45	3.50
adaptor board	81033-3	1.30	3.—
storage scope	81141	3.80	9.—
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E75/76: SUMMER CIRCUITS 1981			
continuity tester	81151	1.25	3.—
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input buffers for the logic analyser	81577	2.—	5.—
E77: SEPTEMBER 1981			
TV games computer extension board	81143	19.—	45.—
disco light controller	81155	3.20	7.50
DFM + DVM	81156	4.25	10.—
revolution counter	81171	4.90	11.50
digital barometer	81173	3.50	8.50
E78: OCTOBER 1981			
RF-test generator	81150	1.60	3.80
economical fridge defroster	81158	1.80	4.35
EPROM programmer	81594	1.45	3.50
wide range dark room timer	82004	2.25	5.50
shutter speed meter	82005	3.75	9.—
LCD panel meter	82011	1.65	4.—
universal LED display	82015	1.60	4.—
E79: NOVEMBER 1981			
teletext			
decoder board	82001-2	5.35	12.50
keyboard section	82001-3	3.15	7.50
sine-wave oscillator	82006	2.10	5.—
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LCD frequency counter	82026	2.—	5.—
high boost	82029	1.85	4.50

E80: DECEMBER 1981

70cm transverter (Oct.)	80133	12.50	30.—
teletext			
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video control board	82001-4	4.25	10.—
VHF-UHF converter board	9864	1.75	4.—
IPROM	82019	1.65	4.—
synthesiser VCO	82027	4.40	10.50
flashing light	82038	1.60	4.—
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E81: JANUARY 1982

EPROM programmer	82010	4.65	11.—
150 MHz frequency counter	82028	3.—	7.—
synthesiser VCF + VCA	82031	4.25	10.—
frequency multiplier	82041	2.05	5.—

E82: FEBRUARY 1982

synthesiser ADSR	82032	4.20	10.—
synthesiser LFO	82033	3.90	9.50
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darkroom thermostat	82069	2.—	5.—
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E83: MARCH 1982

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synthesiser power supply	82078	3.70	9.—
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E84: APRIL 1982

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100 W amplifier	82089-1	2.60	6.—
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2114 RAM tester	82090	1.90	4.50
connection tester	82092	1.55	3.50
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TV sound interface	82094	1.90	4.50

E85: MAY 1982

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display board	81170-2	3.05	7.50
elektor artist	82014	10.05	24.—
Z80-A CPU card	82105	7.05	17.—
polyformant:			
debounce unit	82106	2.45	6.—
input unit	82107	4.65	11.—
tune shift	82108	2.75	6.50
prop-tachometer	82116	2.10	5.—

E86: JUNE 1982

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E87/88: SUMMER CIRCUITS 1982

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sound effects generator	82543	2.40	5.50
slave flash	82549	1.45	3.50
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E89: SEPTEMBER 1982

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keyboard interface	82141-2	2.—	5.—
display	82141-3	2.25	5.50
gas detector	82146	1.60	4.—
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power supply	82147-2	1.50	3.50
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TV games:			
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EPROM plug-in board	82558-2	1.95	4.50

NEW

E90: OCTOBER 1982

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process timer	82142-3	2.—	5.—
active antenna:			
R.F. board	82144-1	1.55	3.50
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DUAL-VCA	9726-F	1.60	4.—
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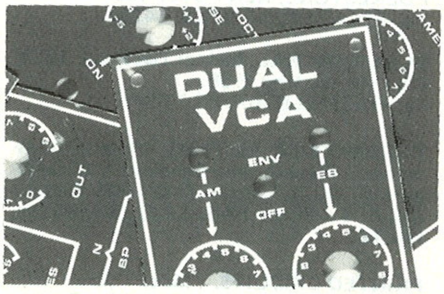

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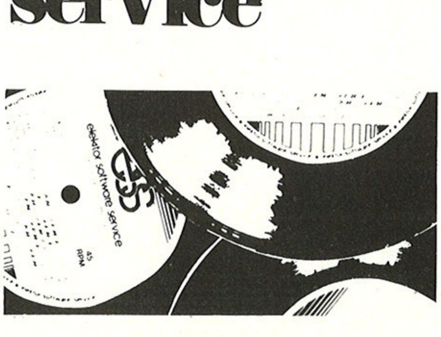

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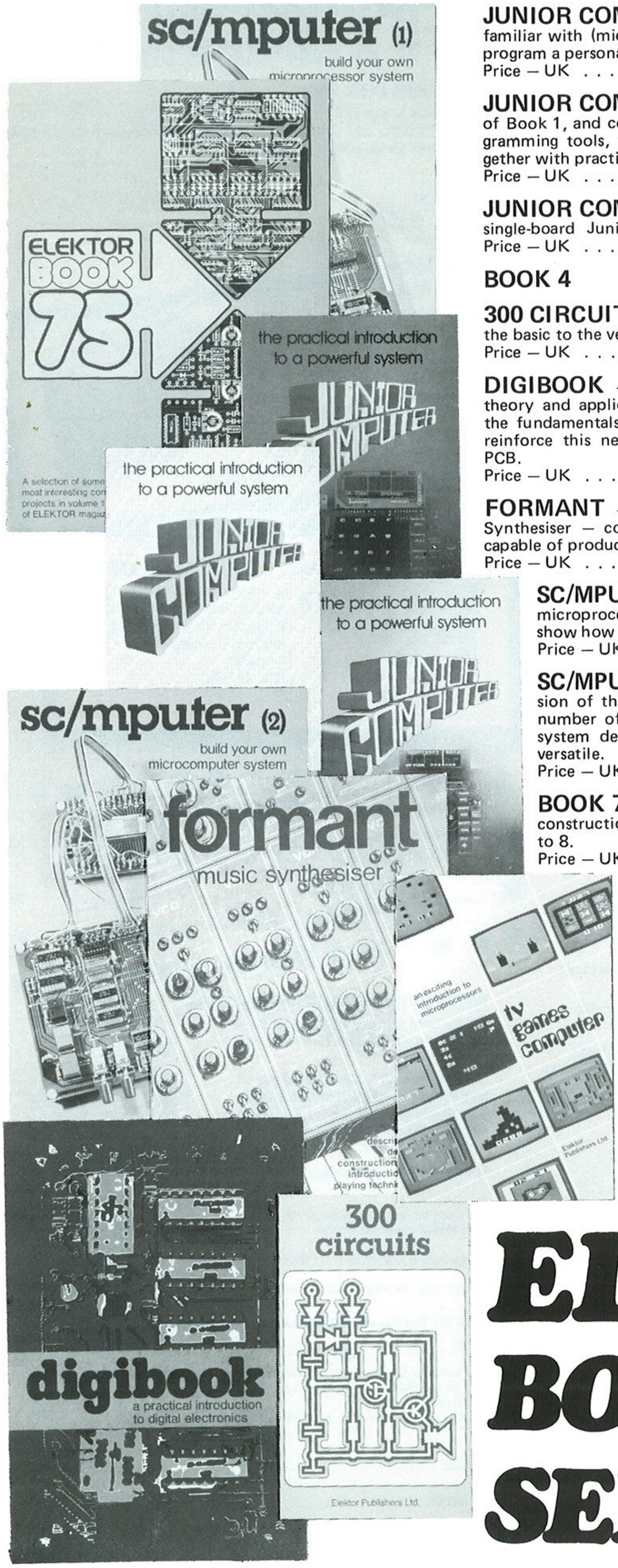

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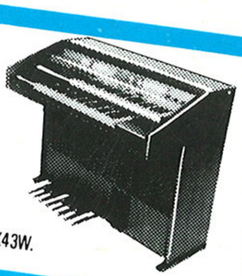

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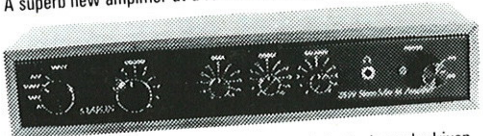

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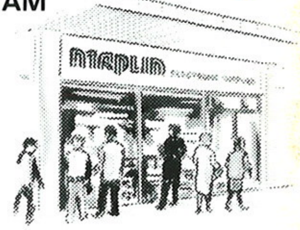

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